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MECCANO MAGAZINE

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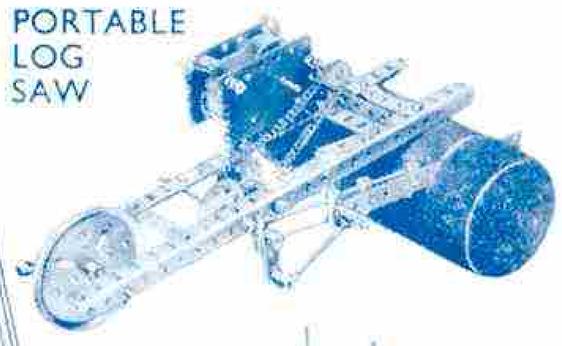
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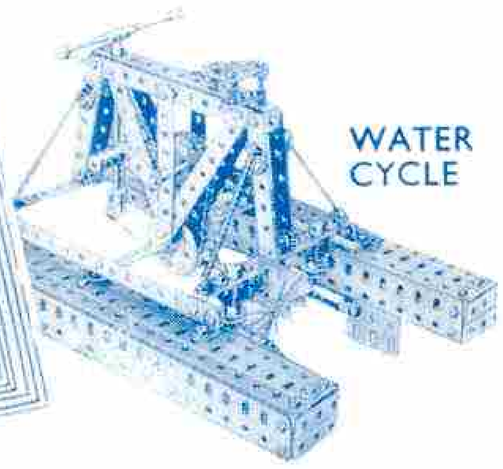
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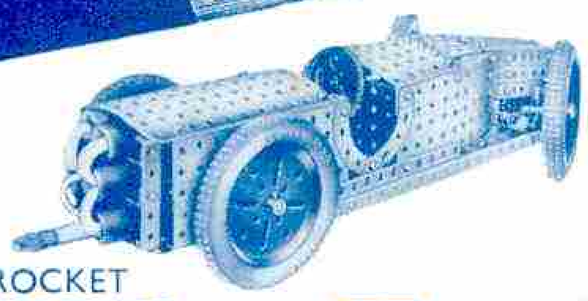
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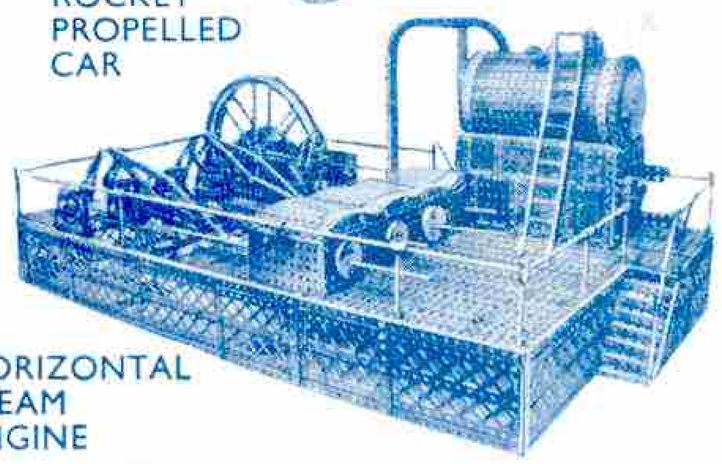
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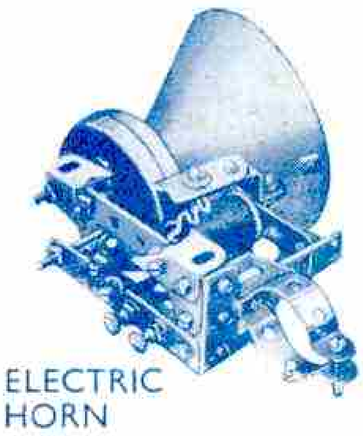
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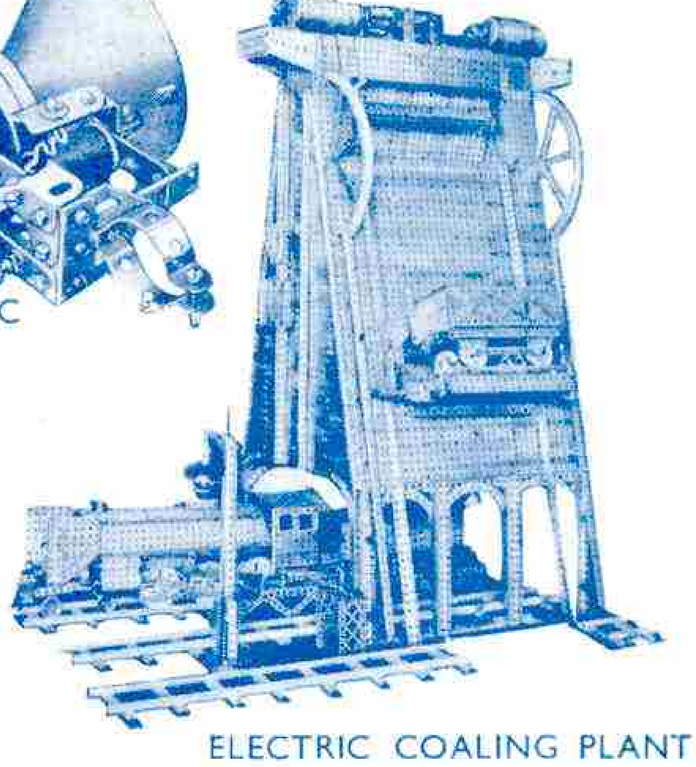
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With the Editor

Meccano Aids Scientific Research

All my readers are aware of the many remarkable purposes for which Meccano has been employed by engineers, inventors and scientists. Formerly an engineer or an inventor who wished to try out a new idea in miniature form before launching on full-scale operations was obliged to make, or have made for him, special parts in wood or metal. This was a laborious and costly process, and quite often the completed parts proved in the end to be useless on account of some flaw in the scheme. In such cases these specially-made parts had to be thrown away because they were of no use for any other purpose. Meccano has altered all this by providing ready-made parts with which almost any mechanical movement can be reproduced, and which remain available for further experiments if a scheme turns out to be unsound.

The remarkable Meccano mechanism described on page 442 of this issue is a striking example of the manner in which Meccano can assist the scientist. Some time ago Professor Hartree of Manchester University determined to try to reproduce the movements of the Differential Analyser, a wonderful machine designed by Dr. V. Bush, a well-known American electrical engineer. This machine automatically solves complex mathematical problems with uncanny speed and accuracy, and Professor Hartree's purpose was to investigate its working and to demonstrate its uses. Meccano had provided him with many happy hours when he was a boy, and had been of great assistance to him on many more recent occasions. Naturally, therefore, he used Meccano parts for the building of this new machine, and the result surpassed his expectations, for the mechanism he constructed was capable of carrying out similar work to that done by the original machine.

The Differential Analyser constructed by Professor Hartree illustrates one of the most valuable features of the Meccano system, namely, its infinite elasticity. The original American machine is built up of a number of units, each playing its own part in the intricate process of solving the difficult mathematical problems with which it is designed to cope; and its range can be extended almost indefinitely by the addition of further units. The elasticity of Meccano has made it possible for the model to be built up and extended step by step to adapt it to new problems. The results that Professor Hartree has already achieved with the model in his research work are sufficient in themselves to justify the claim that it represents the most remarkable scientific application of Meccano parts that has yet been made.

Dr. V. Bush of the Massachusetts Institute of Technology, Cambridge, U.S.A., watching the operation of the Differential Analyser, a wonderful machine he has designed for speedily solving intricate mathematical problems. A working reproduction of this machine in Meccano is described in the article on page 442 of this issue.

Are Thinking Machines Possible?

The triumph of the Bush Differential Analyser and of its Meccano counterpart seems to me to mark an important stage in the development of machines. This development originated in attempts to replace muscular effort by mechanical power. During many centuries steady progress was made in this direction by means of power developed by harnessing wind and water, and then came an enormous stride forward with the introduction of the steam engine. More recent developments in the form of electricity and of internal combustion engines have carried the wave of progress still further, and to-day machinery is employed in transport and industry to such an extent that we have begun to look forward to the time when practically all the world's work will be done mechanically.

Machines have even invaded the office, and to-day they play an important part in occupations that until recently were thought to be beyond their range. The first of the invaders was the typewriter, which has been adopted on a world-wide scale and has completely transformed office work. The typewriter was followed by duplicators that produce copies of original documents at high speed, and by tabulating and accounting machines that may be described as super-clerks, for they add, subtract, multiply and divide figures supplied to them, and even sort these out in such a manner as to produce any desired result in the most convenient form. They carry out their complicated tasks in a much shorter time than would be required by human clerks, and are so accurately constructed that they are practically free from error.

I sometimes wonder if there is any limit to the powers of machinery. The machines I have just mentioned are specially adapted for the repeated performance of certain operations. This is true also of the Differential Analyser, but it seems to me that this machine is capable of something that approaches actual "thinking," along the lines laid down for it by its designer. Thinking machines play an important part in fantastic stories of the future, and writers have even imagined contrivances that could interpret the thoughts of their controllers and pass these on to beings of a different type in a form that is intelligible to them. Many of the strangest things of fiction have already become realities, and it would be rash to prophesy the impossibility of producing machines capable of processes equivalent to a mechanical type of thinking. Truly creative thinking of course will always remain beyond the power of any machine.

Machine Solves Mathematical Problems

A Wonderful Meccano Mechanism

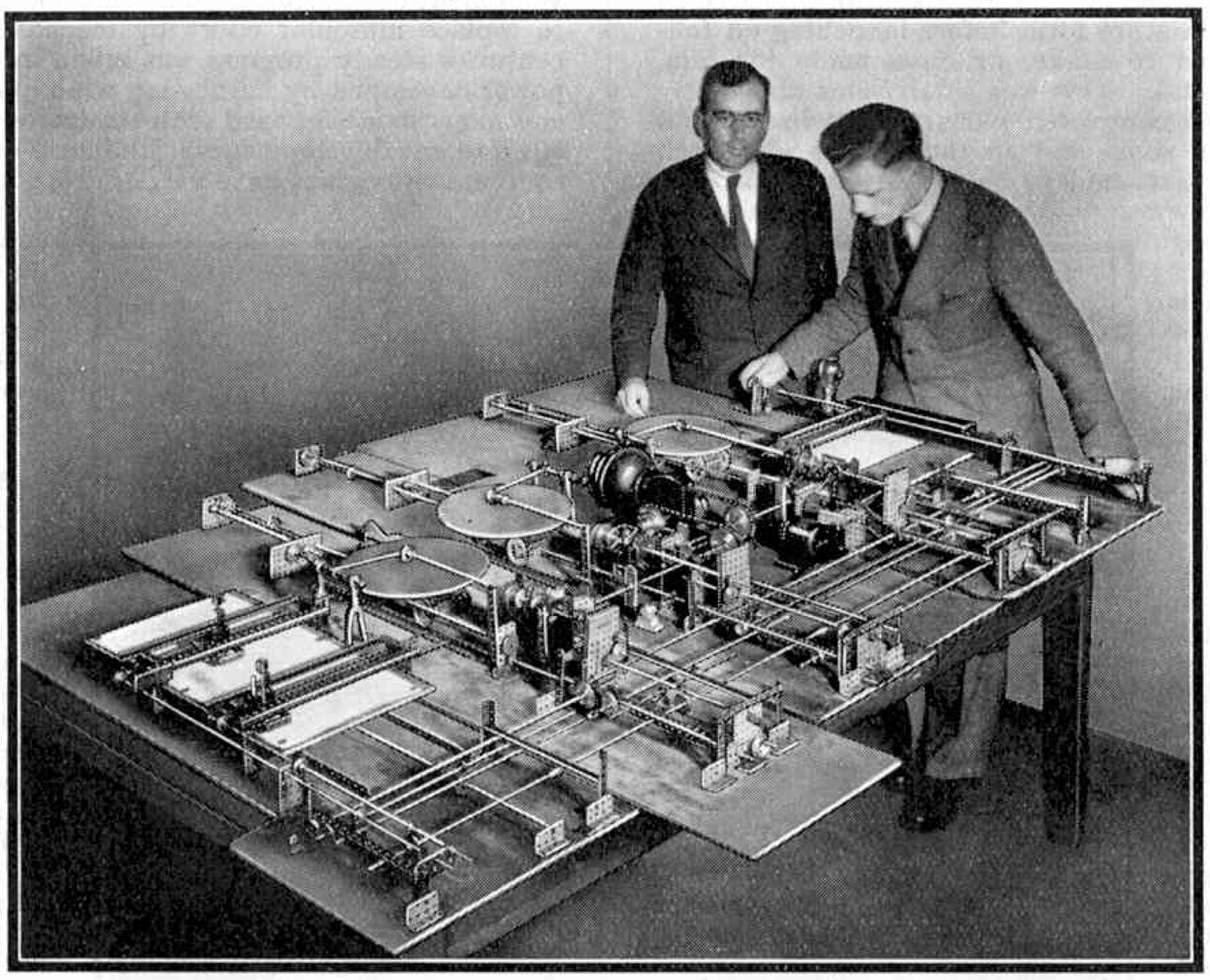
FROM time to time examples have been given in the "*M.M.*" of the readiness with which the most complicated mechanisms can be reproduced in Meccano. An excellent instance of this is the wonderful astronomical clock described on page 170 of our issue for March, 1933, which automatically gives a wealth of interesting and useful astronomical information. More recently Meccano has been used in the construction of a remarkable machine that solves in a few minutes complicated equations that otherwise could only be dealt with by laborious calculations occupying many hours. The original of this model is a machine known as the Differential Analyser that was developed by Dr. V. Bush, Vice-President of the Massachusetts Institute of Technology, Cambridge, U.S.A. In constructing this machine, which at present is the only one of its kind in the world, Dr. Bush's purpose was to shorten the labour of making calculations from the complicated equations met with in working out problems in electrical and other branches of engineering, and also in physics and astronomy.

The solution of these equations is often difficult, and the kind of arithmetical work involved is not well known, and is prolonged and wearisome. Further, human calculators are liable to error, especially in carrying out long series of similar calculations such as are often necessary in work of this kind. These difficulties are avoided by the use of the machine. In a few hours it can be set to provide solutions for equations of astonishing complexity, and then accurate results can be obtained from it in a convenient form in a few minutes.

A general view of the Differential Analyser is given in the upper illustration on the opposite page. It has been described as one of the most comprehensive pieces of mathematical machinery ever built, but in spite of its formidable appearance it is really simple in construction. It consists of an assembly of units that mechanically add, subtract, and carry out other and more complicated mathematical operations, and by adding more units it can readily be enlarged to deal with problems of increasing complexity. As a matter of fact it grows so continuously that its designer has expressed the opinion that it will never really be complete.

The most important mathematical operation that the machine carries out distinguishes it from other kinds of calculating machine, and makes it unique in the range and complexity of problems to which it can be applied. This operation can best be explained by an example. Suppose that a motor car is starting from rest, and that we have a record of its speed at each moment from the start. This record might be in the form of a graph showing how the speed varied with the time from the start; in handling the problem by the Differential Analyser the information actually would be supplied to it in the form of such a graph. From this information we require to know how far the car goes in, say, two minutes. We can find this approximately by dividing the period of two minutes into smaller intervals, for example into 12 intervals of 10 seconds each; and by imagining that the speed remains constant in each interval, then suddenly changes to another constant value in the next interval, and so on. Thus we can find the distance travelled in each period by multiplying each time interval by the supposed constant speed corresponding to it, and finally add up the distances travelled in successive intervals to find the total distance covered.

The result will be only approximate, because the speed actually is not constant in each interval, as we have imagined it to be. The error on this account can be decreased, however, by dividing up the period into smaller intervals, say 24 of five seconds each, or 60 of two seconds each, etc., until the variation of speed in each interval becomes too small to matter. By taking small enough intervals an accurate result can be calculated, however rapidly the speed varies during the total period concerned.



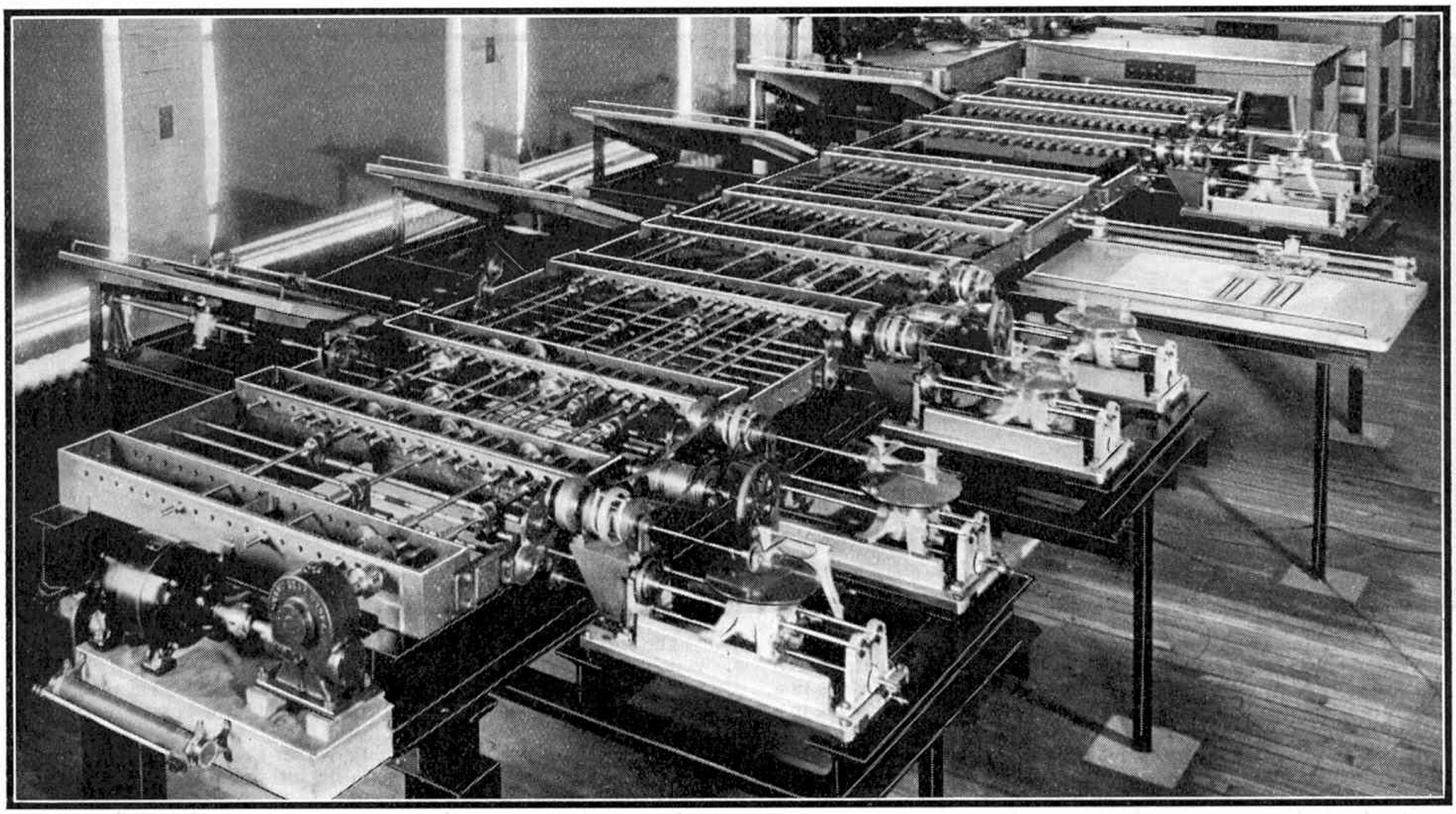
Professor D. R. Hartree and Mr. A. Porter, of the Department of Mathematics, The University, Manchester, with a wonderful Meccano mechanism they have constructed to solve complex mathematical problems. This mechanism is a reproduction on a smaller scale of the Bush Differential Analyser illustrated on the opposite page, and a simpler form of it is illustrated at the top of page 444.

The mathematical operation in which the distance traversed is derived from the speed, which is regarded as known, is technically called "integration"; and the essential feature of the machine is that it incorporates devices called "integrators" for carrying out this operation mechanically. How an integrator works will be described later.

This operation of integration arises in the working out of the most varied problems, in astronomy, physics, chemistry, and engineering, and the scope of problems that can be investigated by the machine is correspondingly wide.

In the centre of the machine is a set of longitudinal shafts, which in our illustration can be seen running from the lower left-hand corner towards the right-hand upper corner. These shafts can be geared to each other so as to rotate at various relative speeds, and the rate at which each turns represents a term in the equation for which a solution is required. The manner in which they are geared depends on the relation between the terms. For instance, if any two terms are to be added together, the shafts representing them are connected with a third by means of differential gearing designed to make the third shaft turn at a speed representing the sum of the speeds of the shafts driving it. More complicated relationships are worked out through special devices such as the integrators already mentioned, which can be seen on the right of the longitudinal shafts; and others known as input tables, which are on the left. Both devices are driven by means of cross shafts.

When the necessary connections have been made, one of the shafts is driven by an electric motor, and in turn drives the other shafts, each at its appropriate speed. When this is done, the speed of the shaft representing the term of which the value is to be found then gives the required solution. For the type of equation dealt with on the machine, the kind of result most usually required is not a single number, but a series of related numbers. For example, in the case of the motor car already considered we wished to know the distance the car travelled in two minutes. To complete our information, however, we require to know how far the car goes in three, four, five, or any other number of seconds. The machine

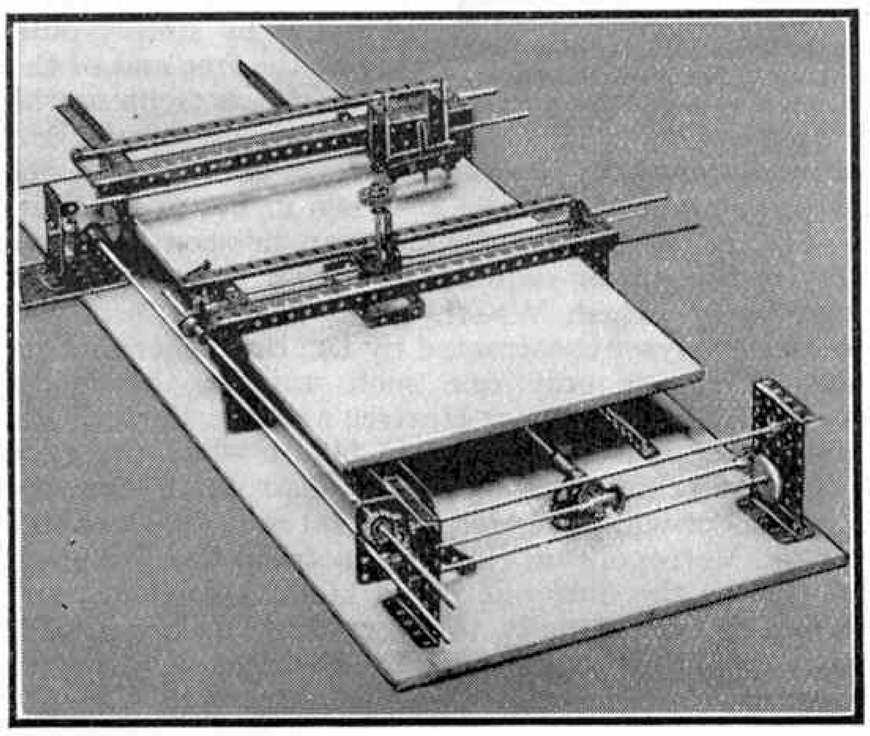


The Bush Differential Analyser at the Massachusetts Institute of Technology, Cambridge, U.S.A. This machine is illustrated also on page 441. We are indebted to the courtesy of Dr. V. Bush for our photographs. Below are the output (left) and input tables of the Meccano reproduction of the machine described in this article.

provides this solution in a very ingenious manner, for the shaft representing distance travelled—the solution of the equation—is made to drive through cross shafts a pencil that moves across a sheet of paper pinned to a board, and this itself is moved at right angles through similar gearing connected to the longitudinal shaft representing time. Thus the pencil draws a curve that shows how the distance travelled increases with the time, and this is the solution to the equation.

The board on which this curve is drawn is called the output table, and in our photograph of the machine is shown on the right of the horizontal shafts. If the pencil were driven from a shaft representing the distance travelled by the car, the curve drawn then would enable the distance at any instant to be found, and the machine can readily be adjusted to give solutions in alternative forms as may be desired. In practice curves for two quantities concerned in the solution can be drawn by using two pencil carriages.

The Meccano model of this ingenious machine was designed and constructed by Professor D. R. Hartree, F.R.S., of the Department of Mathematics, The University, Manchester, and Mr. A. Porter, and is shown in the upper illustration on page 444. It was built for the purpose of demonstrating the principles on which the Bush Differential Analyser works, but it turned out to be more than a demonstration model, and to be capable of solving many equations with a considerable degree of accuracy. It is simpler than the original, but has just the same flexibility, and its range of operations can be increased by the addition of new units. Professor Hartree is finding it of great value in connection with his researches on electrical problems connected with the constitution of the atom, and thus Meccano is playing an important part in an interesting field of scientific work.

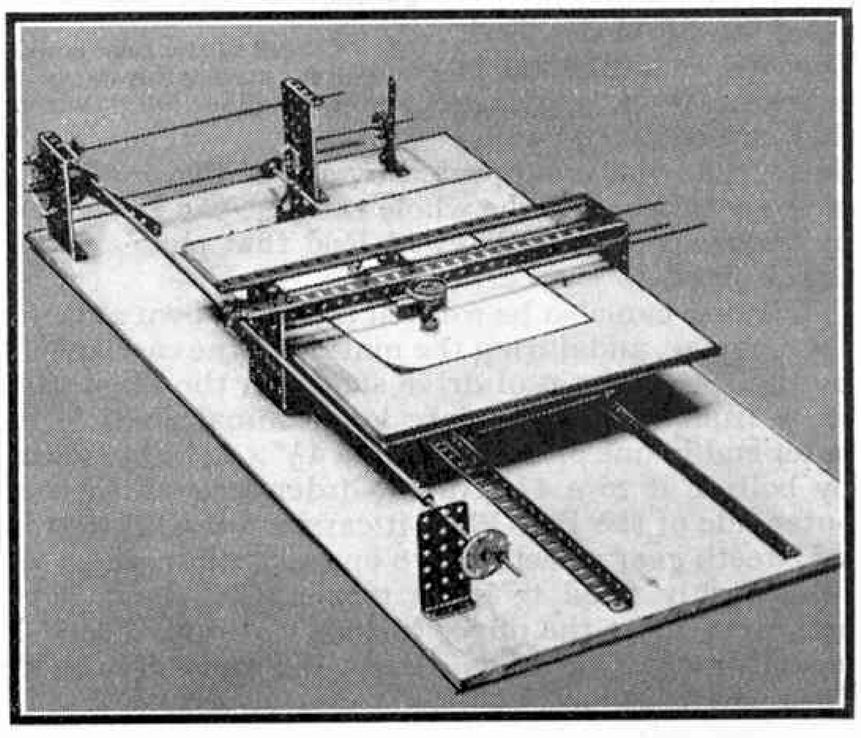


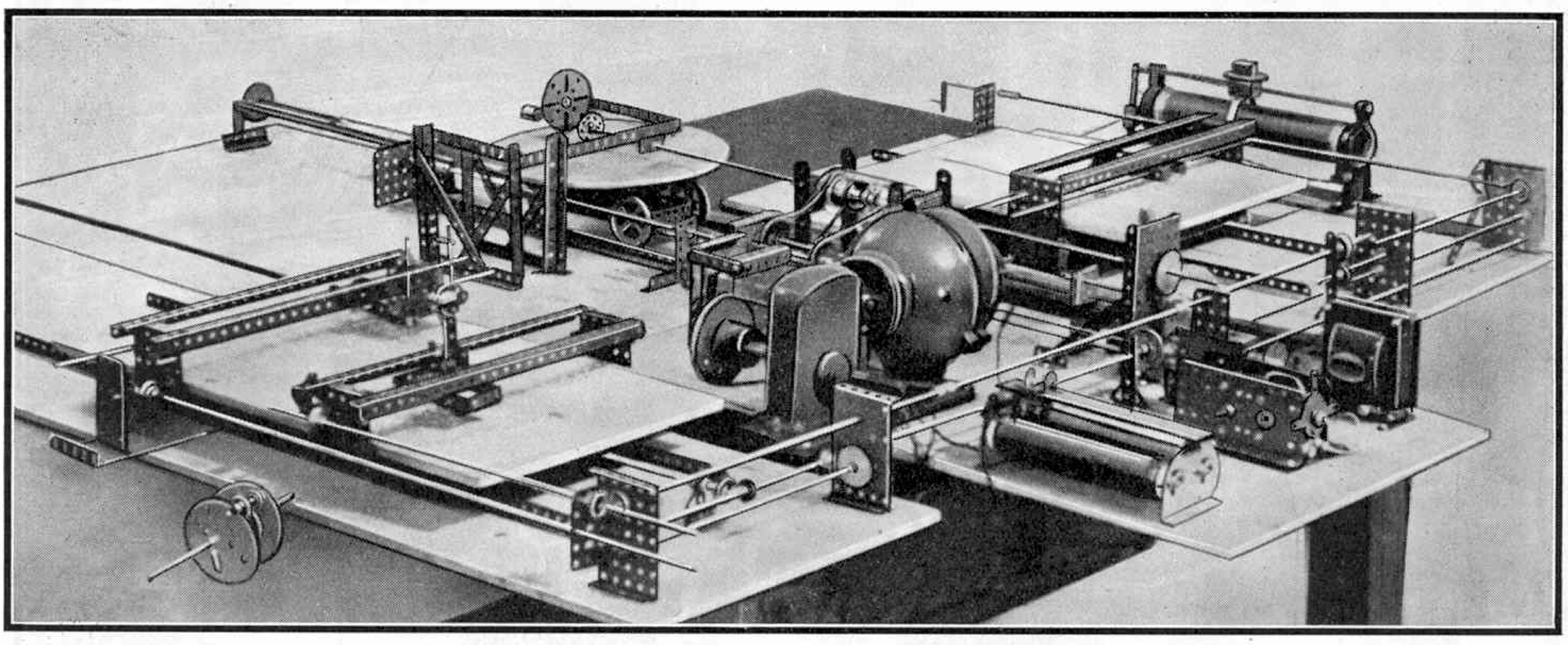
As will be seen from the illustration on page 444, the general layout of Professor Hartree's model is similar to that of the Bush machine. The shafts consist of Axle Rods joined where necessary by means of Couplings in order to provide the necessary length. These shafts are journalled in holes in suitable positions in $3\frac{1}{2}'' \times 2\frac{1}{2}''$ Flanged Plates screwed to the table, and drive the cross shafts, also consisting of Axle Rods, by means of $\frac{7}{8}''$ Bevel Gears. A 6-volt Meccano Electric Motor is employed to drive the shafts, and this, together with its transformer, can be seen on the right of the photograph.

The output table of the machine is shown in detail in the left-hand lower corner of this page. The pencil that draws the output curve is supported by a carriage, built of Meccano parts, that moves along two Axle Rods that support it and are fitted in a framework of Girders bolted to $3\frac{1}{2}'' \times 2\frac{1}{2}''$ Flanged Plates screwed down to the table. This is moved by the rotation of a Screwed Rod that passes through a Threaded Crank fixed to the carriage, and is fitted with Collars where it passes through the Flanged Plates so that it cannot move along its length. The Screwed Rod is driven by $\frac{7}{8}''$ Bevel Gears from a cross shaft, which is similarly driven from the main shafts of the machine.

The output table is moved at right angles to the direction followed by the pencil. The drive from the appropriate main shaft is transmitted to it by a Screwed Rod passing under it through a Threaded Crank bolted to an Angle Girder screwed to the under side of the table. A second pencil carriage is provided, as in the original machine. The additional cross shaft can be seen on the left, below the first one.

The input table of the machine is shown in the right-hand lower corner of this page, together with a part of the longitudinal shaft system that has been disconnected from the rest of the machine for convenience in obtaining a photograph. Its purpose is to enable two shafts connected



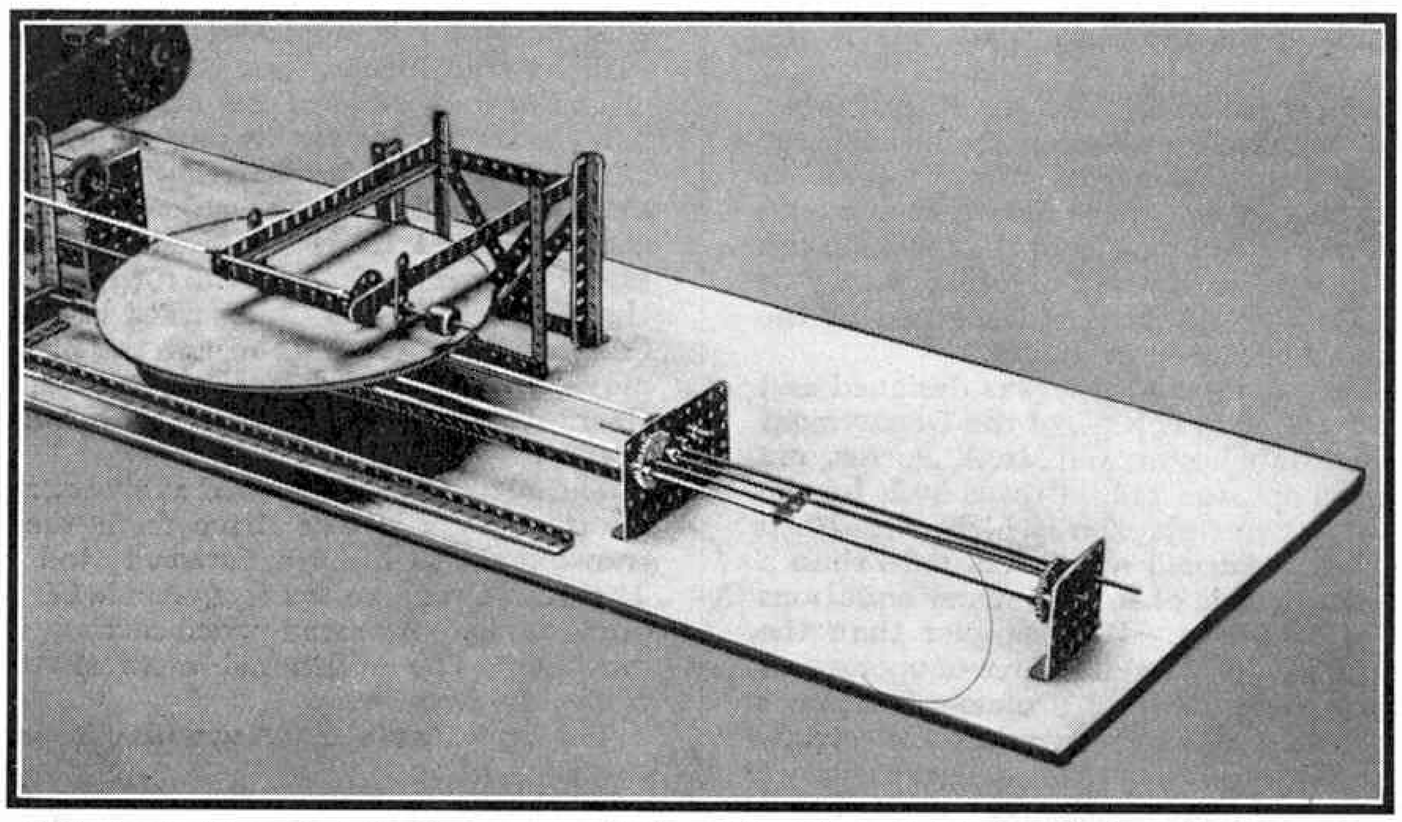


to it to be rotated at speeds that vary continuously relative to each other. To enable this to be done, a curve to represent the required relation is drawn on paper pinned to the table, which moves in a direction at right angles to the longitudinal shafts, and is driven in a similar manner to the output table. A pointer on a moving carriage similar to those already described is kept as nearly as possible on the curve by turning the Bush Wheel, provided with a Threaded Pin as a handle, shown on the right. The motion is transmitted to the pointer by $\frac{7}{8}$" Bevel Gears and a length of Screwed Rod, and the appropriate speed is communicated to one of the shafts in the main assembly to which it is geared. Thus the two longitudinal shafts concerned are rotated at their correct relative speeds when the machine is in operation.

In solving the complicated equations for which the machine is designed it is necessary to connect longitudinal shafts together in a more complex manner than the use of an input table allows. Three shafts are concerned in these cases, the rate of rotation of one depending on that of the second and on the total rotation of the third. The connection is established by means of the integrator. This is the round horizontal disc shown in the illustration of the machine, and in the lower illustration on this page, on the upper surface of which rolls a wheel that can rotate about a horizontal axis.

To the under side of the horizontal disc is screwed a Bush Wheel, into the boss of which is fitted a 3" Axle Rod. This rod is journalled in bearings in a carriage that can be moved along rails. The disc is supported by a Rail Bearing that also forms part of the carriage, and the whole carriage can be moved along the rails by the rotation of a Screwed Rod that passes through a Threaded Crank fixed to the carriage.

The disc can also be rotated about its own axis in any position of the carriage, and during the motion of the carriage ; this is achieved by the special form of drive shown in the illustrations. The cross shaft from the appropriate longitudinal shaft is journalled at its outer end in one of the holes in a $4\frac{1}{2}" \times 2\frac{1}{2}"$ Flat Plate held vertically by bolting it to a $4\frac{1}{2}"$ Angle Girder screwed in the table. On the outer side of the Flat Plate it carries a pinion that indirectly drives a 57-teeth gear wheel, in two opposite outer holes of which are Axle Rods firmly fixed to it by means of Collars. There is a similar arrangement at the opposite ends of the two Axle Rods, giving an assembly that turns as a unit in obedience to the drive of the cross shaft.



At the head of the page is the Meccano reproduction of the Differential Analyser in its earliest form, from which the mechanism shown on page 442 was developed by the addition of new units. The lower illustration shows one of the integrators of the model. These photographs and those at the foot of page 443 are reproduced by courtesy of Professor D. R. Hartree.

The two Axle Rods pass through the holes of a Double Arm Crank, which of course turns with them. The shaft that actually drives the rotating table is secured to the boss of the Double Arm Crank by means of a set screw, and passes freely through the boss of one of the 57-teeth Gear Wheels, as shown in the illustration. As the position of the carriage changes, the Double Arm Crank moves along the two Axle Rods, and thus there is no interruption to the turning movement given to it.

The combination of the two movements described has to be communicated to one of the horizontal shafts. This is done by means of the Bush Wheel that rests on the rotating table, and is turned by it. The speed at which the Bush Wheel turns depends on the rate at which the disc is turning, and also on its distance from the centre of the table. The actual position of the Bush Wheel is fixed, so that if the disc is turning at a constant rate, and the carriage on which it is mounted is moving, the speed of rotation of the Bush Wheel varies continuously, and this rotation is communicated to one of the longitudinal shafts of the machine by means of a cross shaft and Bevel Gears.

The torque, or turning power, of the Bush Wheel is very small ; and in itself is far from sufficient to drive the longitudinal shaft to which it is connected. Its effect therefore is multiplied by means of a special device that acts on the capstan principle. In this a rotating pulley is made to grip a rope given two or three turns round it by simply pulling at the free end of the rope, which tightens the turns and gives sufficient grip for the turning power of the capstan to take effect. The device that applies this principle in the model is shown in the upper illustration on this page, in the centre of which can be seen the large motor that provides the power required to drive the cross shaft that is controlled by the Bush Wheel.

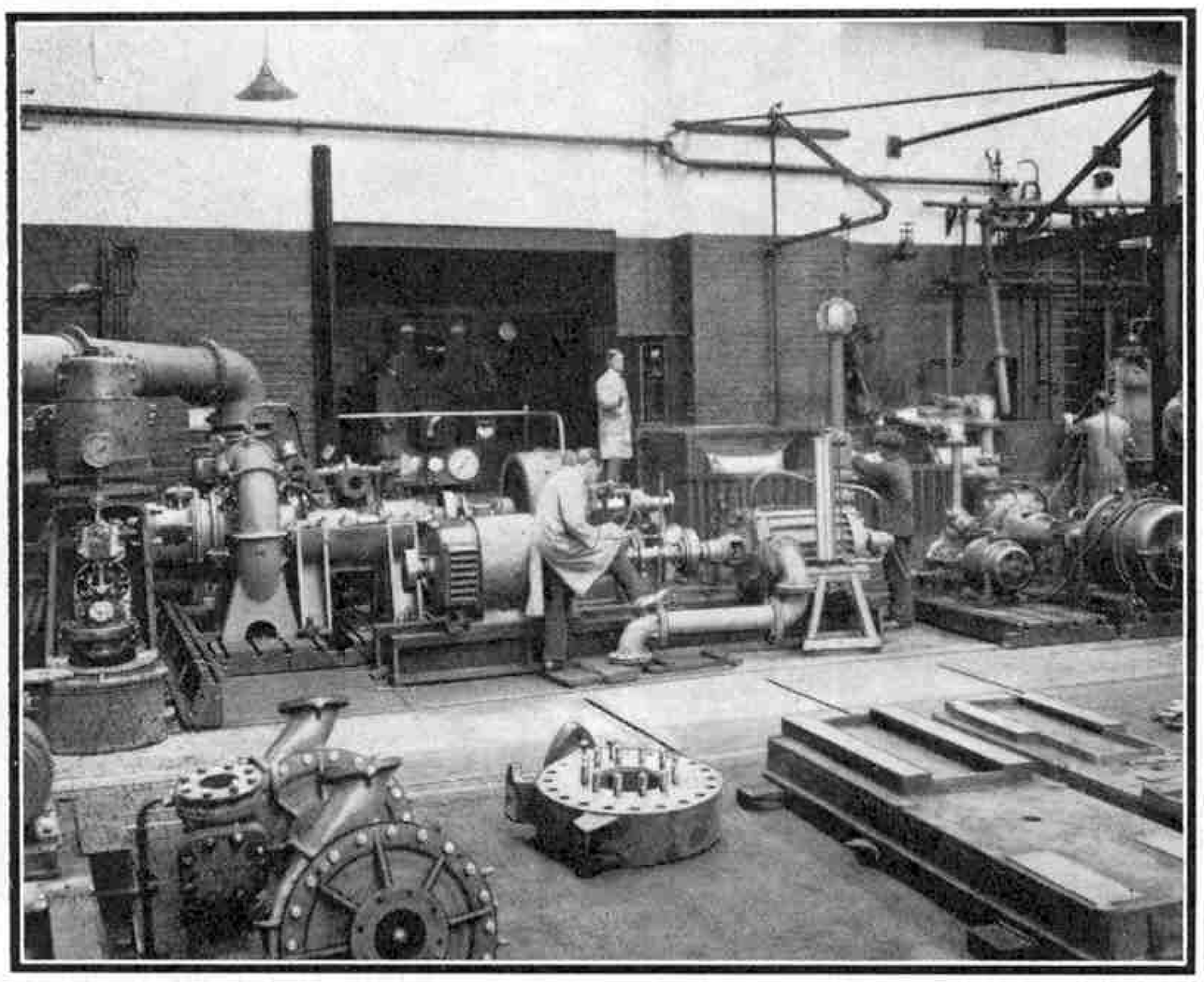
In the Differential Analyser constructed by Dr. Bush there are six integrating units. There is only one such unit in the model described in this article, but Professor Hartree and Mr. Porter have constructed a new model, illustrated on page 442, in which there are three. A full-sized machine now under construction for the University of Manchester will have eight integrators. This machine is being built by the Metropolitan Vickers Electrical Co. Ltd., and when completed will be the only one of its kind in England, and one of the first two, if not actually the very first, in Europe.

We are greatly indebted to Professor Hartree, F.R.S., for valuable assistance in the preparation of this article.

How Things Are Made

A Modern Centrifugal Pump

IN common with nearly all other engineering products, pumping machinery has been greatly improved both in design and methods of production during the last 50 years. Much of the progress that has been made lies to the credit of the Pulsometer Engineering Company Ltd., Nine Elms, Reading, a firm that was started over 55 years ago for the manufacture of the "Pulsometer" steam pump. This latter is a peculiar type of pump that works on the same principle as the human heart, the alternate expansion and contraction of steam in two chambers of the pump sucking in water and pushing it out at the delivery branch. About 1890, however, the coming of the electric motor gradually gave centrifugal pumps the ascendency over all other types, and although the "Pulsometer" steam pump is still in extensive use, the centrifugal pump is now the most widely employed.



The hydraulic test bed at the Nine Elms Works, Reading, of the Pulsometer Engineering Company Ltd. A centrifugal pump is undergoing accurate tests for output and current consumption.

A centrifugal pump consists of a chamber inside which a bladed wheel or impeller, very similar to a turbine wheel, revolves at high speed. The water is drawn in through a suction pipe, which divides so as to enter the pump impeller on each side. The water rotating in the pump wheel passes outward, and if the speed is sufficient a continuous flow is maintained through the pump chamber and into the discharge pipe. The water thrown off by the impeller with a high swirling velocity is allowed to continue rotating in a chamber somewhat larger than the pump where the energy of the swirling water is utilised instead of being wasted in useless eddies in the discharge pipe.

The action of a centrifugal pump may be easily understood by considering for a moment an everyday example of centrifugal force, namely, a stone swung round at the end of a string. The rotating force supplied by the hand causes the stone to whirl round at high velocity, and the faster it travels the greater becomes the tension, or centrifugal force, on the string, so that if the string is released the stone will fly sharply off at a tangent.

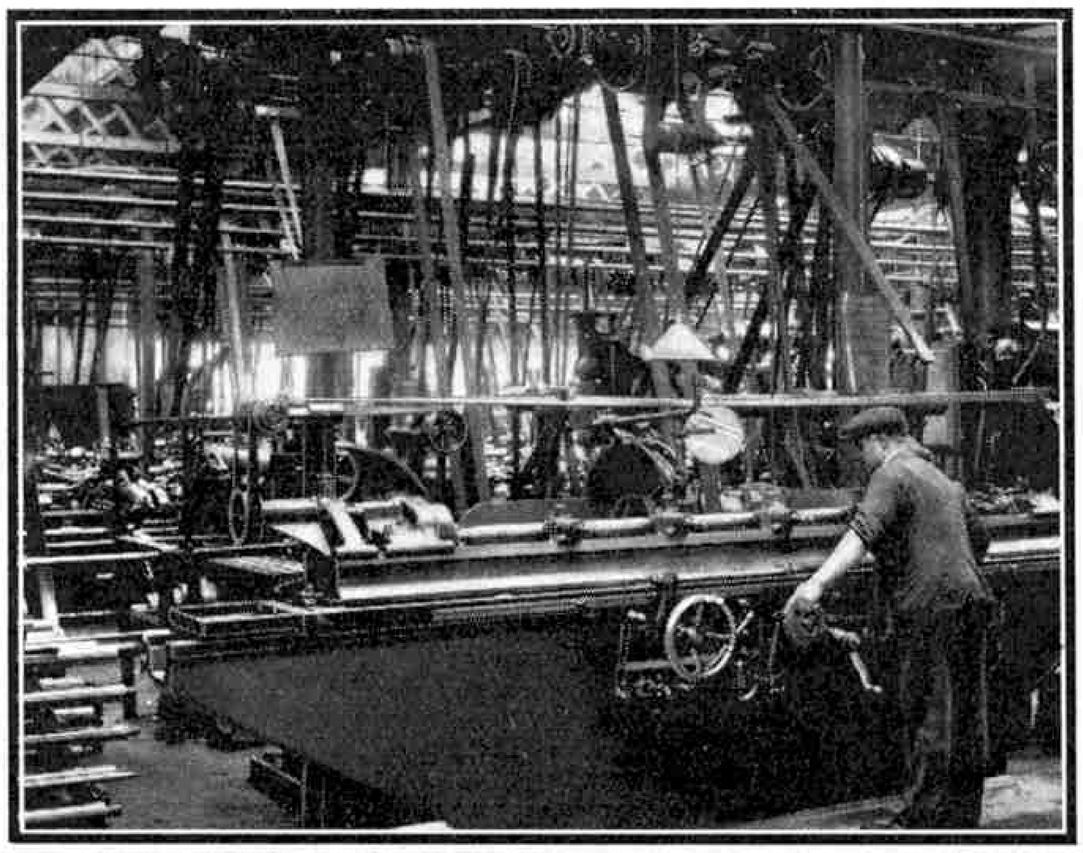
In a centrifugal pump the impeller supplies the rotary motion, and imparts great velocity to the water. As the water cannot escape at a tangent like a released stone, it presses hard against the casing until it arrives at the opening of the delivery branch, when the pressure that has been developed forces it up the delivery pipe.

In multi-stage centrifugal pumps the principle is the same, but by means of carefully designed plates known as diffusers, which are set between the impellers, the water is passed from the outlet of one impeller to the inlet of the next impeller. Each of these impellers increases the pressure, until, when the delivery branch is reached, the pressure developed is sufficient to force the water to great heights, 3,500 ft., or about two thirds of a mile, having been recorded.

There are practically no pumping duties that a centrifugal pump cannot perform, and the field of application has been greatly extended within recent years. High lift centrifugal pumps are employed for mine drainage, shaft sinking, irrigation, land reclamation, boiler feed, making canals through soft soil, water works, pumping solids and abrasive matter, feeding hydraulic high pressure systems up to 1,500 lb. per sq. in., and many other duties.

The manufacture of a modern centrifugal pump at the Nine Elm Works involves many interesting processes. After the chief engineer and his staff have worked out a satisfactory design, it is passed to the draughtsmen, who make the necessary detailed working drawings. When these have been checked and approved, they are sent to the pattern shop, where wood patterns are made exactly the shape of the various parts of the proposed pump.

The patterns then go to the foundry, where they are impressed in fine loamy sand so that an imprint of their shape is left when they are withdrawn. These shapes are called moulds. Other shapes called cores are then prepared exactly to the shape of the inner surface of the pump, but of sufficiently smaller size than the outer mould to allow the requisite thickness of metal to form between them. All cores and large or intricate moulds are placed in a large oven and baked hard. Holes are left in the surface of the mould at each end, and through one of them molten metal is poured until it rises to the surface through the holes at the farther end, showing that the mould is full.



A corner of the Machine Shop at Nine Elms Works, showing a grinding machine finishing the spindle for a centrifugal pump.

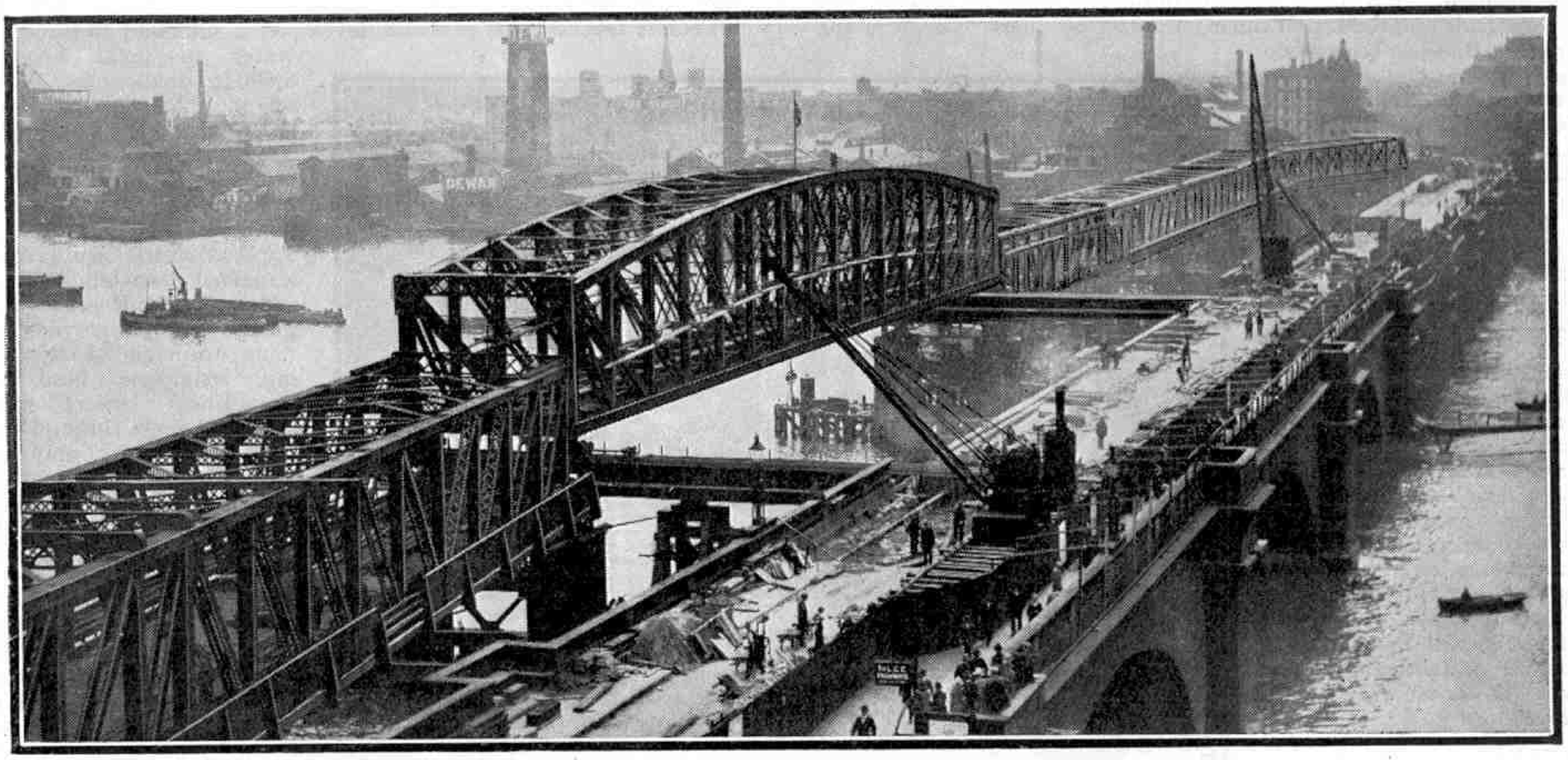
The metal from which the casting is to be made is placed in a furnace, along with the firing fuel, so that there are alternate layers of coke and metal. When the metal melts it runs down to the bottom of the furnace, where it is drawn off in large iron ladles handled by overhead cranes. The ladles carry the molten metal to the moulds, into which it is poured through the holes already described. After the metal has cooled the moulds are broken open, and the rough castings are carefully inspected for faults.

The castings are sent to the machine shop to be turned, bored and faced, after which milling and grinding (*Continued on page 500*

The Future of Waterloo Bridge

Rennie's Famous Structure Still in Dispute

By R. D. Gauld, M.Eng., A.M.Inst.C.E.



The above photograph shows Waterloo Bridge and the temporary steel bridge built alongside it. The 280 ft. centre span is ready for lowering into place by hydraulic jacks.

THE keen and prolonged discussion in regard to the fate of Waterloo Bridge has aroused great interest in London and throughout the country, and indeed abroad, for ever since its erection the structure has been regarded as an architectural masterpiece. Canova, the great Italian sculptor who died in 1822, described it as "the noblest bridge in the world," and declared that it was "alone worth coming from Rome to see." Unfortunately the bridge threatens to become unsafe. The London County Council therefore proposed to build a new and wider bridge, but this plan was opposed on various grounds, and last year the Government scheme for reconditioning the existing structure was agreed to. The newly-elected Council have now decided not to accept this solution and are pressing for the necessary powers to build a new bridge more in keeping with the present day requirements of traffic on land and on the river.

The project of a bridge to connect the Strand near Somerset House with the Surrey side of the Thames at Lambeth dates back to 1809, when an Act of Parliament was passed incorporating the Strand Bridge Company for the purpose of building a bridge across the river. A plan was submitted by George Dodds, a well-known engineer of the time, for a bridge of nine arches each of 130 ft. span. The company referred the plan to John Rennie, senior, who had achieved a great reputation in this country as a builder of bridges. Rennie criticised several features of the design, and of the method proposed for making the foundations. Later, when the Act authorising the construction of the bridge had been passed, the company again applied to Rennie and requested him to design a suitable bridge.

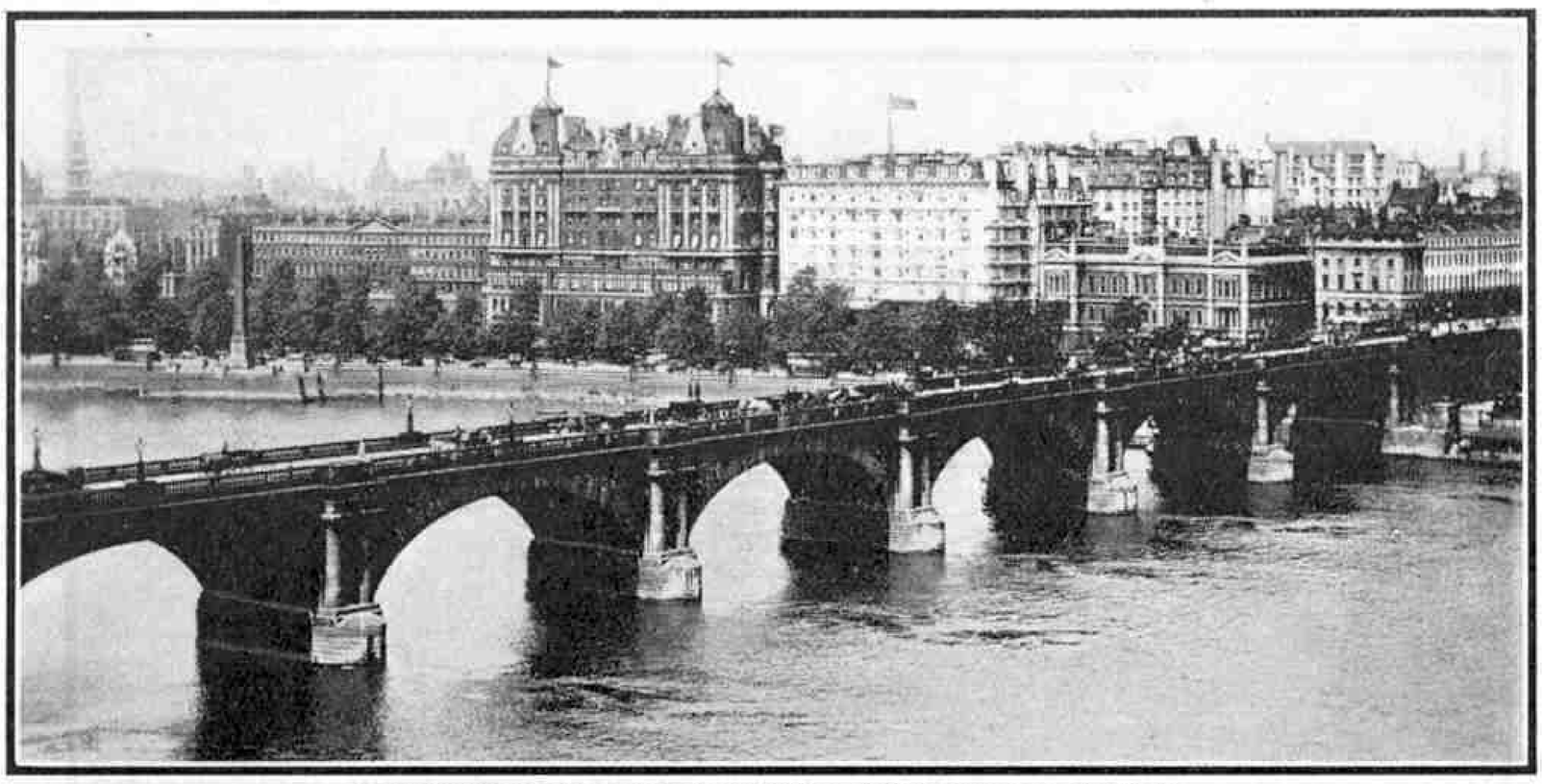
Rennie's first step was to make an entirely new chart of the river and its shores after a careful survey had been made by Francis Giles, an expert land surveyor whom Rennie had frequently employed to carry out the hydraulic surveys for the canals and harbours on which he was engaged. Two designs were prepared, one with seven equal arches and the other with nine; and after due consideration the nine-arch scheme was ordered to be carried out.

The engineer Dodds had proposed to found the piers of his bridge by means of caissons, but Rennie decided to use cofferdams. A cofferdam may be described as consisting of two concentric rings of piles driven in contact with one another around the area on which the foundation is to be built. The space between the two rings is packed tightly with clay so as to make the enclosure watertight, and the water inside is pumped out. Excavation to the proper depth is then made, the foundation is laid, and building operations proceed until the pier has reached a height above the level of the outside water. The cofferdam is then removed.

Piles about 22 ft. long were driven into the bed of the Thames, the lower 18 ft. or so of each pile being in clay and the upper portion in gravel. The number of piles under any one pier varied from 176 to 319. On the heads of each group of piles a timber platform 2 ft. 6 in. thick was laid, and the masonry of the pier was erected on this base. The first stone was laid on 11th October, 1811, over

an inscribed plate and gold and silver coins.

The arches of Waterloo Bridge were built up on timber "falsework" or "centring." As the centring cannot be removed until the arch is complete and the mortar has set, it must be very strong, and the massive construction of this temporary timber work may be realised from the fact that the centring for a single arch of the bridge weighed 400 tons. As the arches are all of the same span, one centre could be used several times.

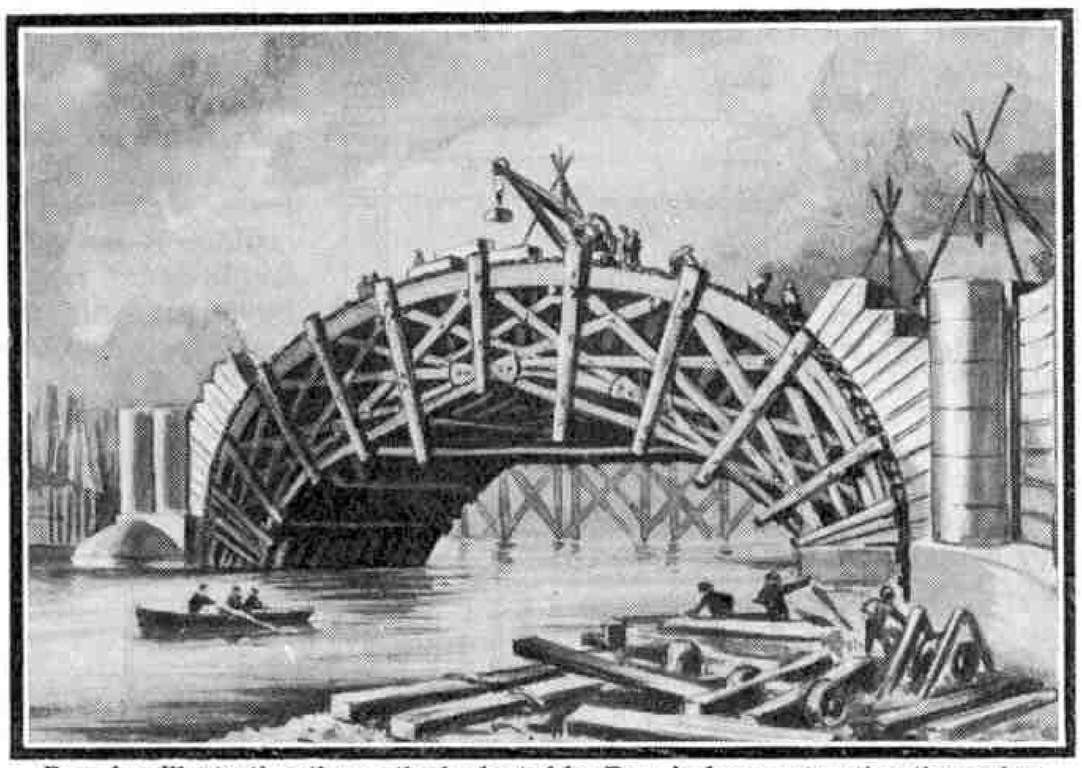


View of the Bridge before the erection of the temporary structure.

The method employed by Rennie for constructing, floating and fixing the centring was very ingenious. Each centre consisted of eight ribs on the truss principle, resting on wedges supported on struts placed on the offsets of the piers and abutments. The ribs of each centre were connected together by transverse and diagonal ties, as well as planking on which the arch-stones rested. The centres were constructed on a platform by the riverside, floated between the piers on barges specially built for the purpose, and raised into their proper places by means of four powerful screw jacks fixed in cast iron boxes firmly bedded in the solid floor of the barge. The scheme proved so successful that the fixing of one centre was usually completed within a week. This method was new at the time, and it is of interest to note that it was the same as that afterwards followed by Robert Stephenson in fixing the great tubes of the Conway and Britannia Bridges. The maximum settlement of any arch when its centre was struck was $2\frac{1}{2}$ in. to $3\frac{1}{4}$ in., a very small amount for such large arches.

Before the Victoria Embankment was constructed the Thames was 1,326 ft. wide opposite Somerset House, and Waterloo Bridge was built 1,380 ft. long, with a northern approach of 310 ft. and a southern approach of 766 ft., making a total of 2,456 ft. There are nine equal semi-elliptical arches, each of 120 ft. span with a rise of 34 ft. 6 in. The arches were a bold venture, for they were flatter than any built up to that time. The long inclined approach on the south side is carried on 39 semi-circular arches each of 16 ft. span, one elliptical arch of 26 ft. span, and an embankment 165 yds. long with a gradient of 1 in 34.

The main arches are carried on piers that have semi-circular ends, or "cut-waters," to divide the current of water. These piers are 20 ft. wide and have projecting buttresses supported by two three-quarter Doric column pilasters, after the design of the temple of Segesta in Sicily. The arch that is used chiefly by shipping has a headway of 46 ft. above low water at spring tides, with a water depth of 5 ft. 11 in. At high water of full tide the headway is 26 ft. 8 in. The arches are surmounted by a parapet topped by a stone balustrade made of Aberdeen granite. Cornish granite was used for the arches and the exterior face of the bridge, while most of the interior stone is a hard sandstone from Derbyshire and Yorkshire. All stonework except that used for the balustrade was dressed in a field near the south end of the bridge, and was conveyed to the site on trucks drawn along light rails laid, at first, over temporary wooden bridges.



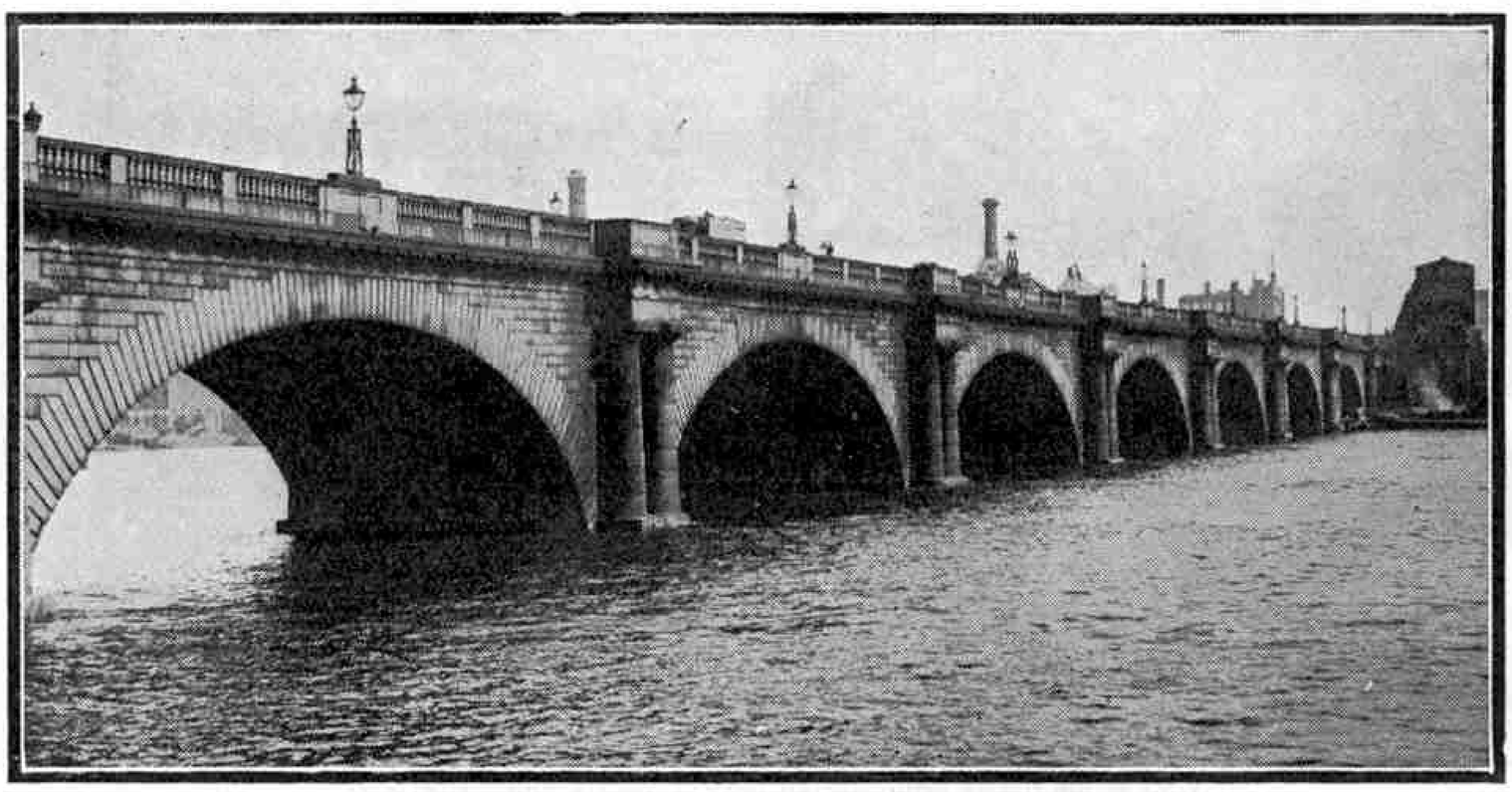
Drawing illustrating the method adopted by Rennie for constructing the arches.

Rennie makes an amusing reference to this part of the work in his notes on the construction of the bridge. "It is singular," he says, "that nearly the whole of the stone for the bridge should have been drawn by one horse, familiarly termed by the workmen 'Old Jack,' who was a most sensible animal, and did his duty in a most exemplary manner, being always in good trim and ready. Tom, his master, used to call at a public-house. On one occasion he remained there longer than usual. At length the horse put his head in at the door, and taking Tom by the sleeve pulled him out of the house. Tom took the hint, and was never afterwards found loitering during work hours."

The roadway above the piers is supported by six brick walls 2 ft. 3 in. thick, covered with corbel stones. It was formed by a layer of puddled clay 15 in. thick, then a layer of lime and fine gravel 3 in. thick, followed by a layer of granite, broken in pieces 2 in. in diameter, 1 ft. thick. The roadway for carriages is 28 ft. wide and the footpaths on each side are 7 ft. wide. Through the centre of the masonry of each pier a hole 18 in. in diameter was cut, entering the river at one side of the pier at low water; and from the top of the hole inside the pier pipes were led to drains on each side of the roadway, thus effectually carrying away all rain and surface water into the river.

Until 1803 practically all bridges in this country were built with a "hump back"; in other words,

the road rose from each end of the bridge towards the centre, sometimes very steeply. This hump was supposed to improve the appearance of the bridge, and of course added to its strength if the abutments, or shore ends, remained firm. Rennie departed from this principle in the first important bridge he built, a five-arch structure across the Tweed at Kelso, and one of the first bridges in this country to have a level roadway. This bridge was completed in 1803, and its success no doubt influenced Rennie in designing Waterloo Bridge, which resembles the Kelso Bridge in many ways, although of course it is much larger. The roadway of Waterloo Bridge is only about 2 ft. above the level of the Strand, and is not inclined towards the centre.



A closer view of Waterloo Bridge, showing its symmetrical beauty.

Shortly before the bridge was completed an amending Act was passed that declared that the name should not be "Strand Bridge," as originally intended, but "Waterloo Bridge," in commemoration of the Battle of Waterloo and in honour of the Duke of Wellington. The bridge and its approaches were completed and opened with great ceremony in June 1817 by George IV, then Prince Regent, who was accompanied by the Duke of Wellington. At the opening ceremony the Prince Regent offered to confer the honour of knighthood upon Rennie, who respectfully declined it. Writing afterwards to a friend, he said: "I had a hard business to escape knighthood at the ceremony." He preferred to remain simply John Rennie, engineer of the noble structure he had successfully brought to completion.

In 1882 the Metropolitan Board of Works, who had taken over the bridge from the old company, carried out extensive work to protect the foundations from the scour of the river.

The weight of the bridge is very much greater than that of any load that can come upon it. According to the report of the Royal Commission on Cross River Transport, the load on each pier of Waterloo Bridge is about 10,000 tons. Until a few years ago the bridge was as sound as on the day it was built, but in October 1923 the fourth pier from the south end began to subside noticeably. In the following month attempts were made to inject cement into the gravel under this pier, but they were not successful, and in May 1924 the bridge was closed while more effective repairs were carried out. The roadway and parapet over the defective pier were replaced by lighter material. Timber centres were put under the fourth and fifth arches, and this stopped the settlement, which from October 1923 to June 1924 amounted to 11 in., the pier also becoming five in. out of plumb. The total subsidence of the fourth pier from the south from 1820 until March, 1925, was just over 2 ft. 4 in., and slight settlement had taken place in all the other piers.

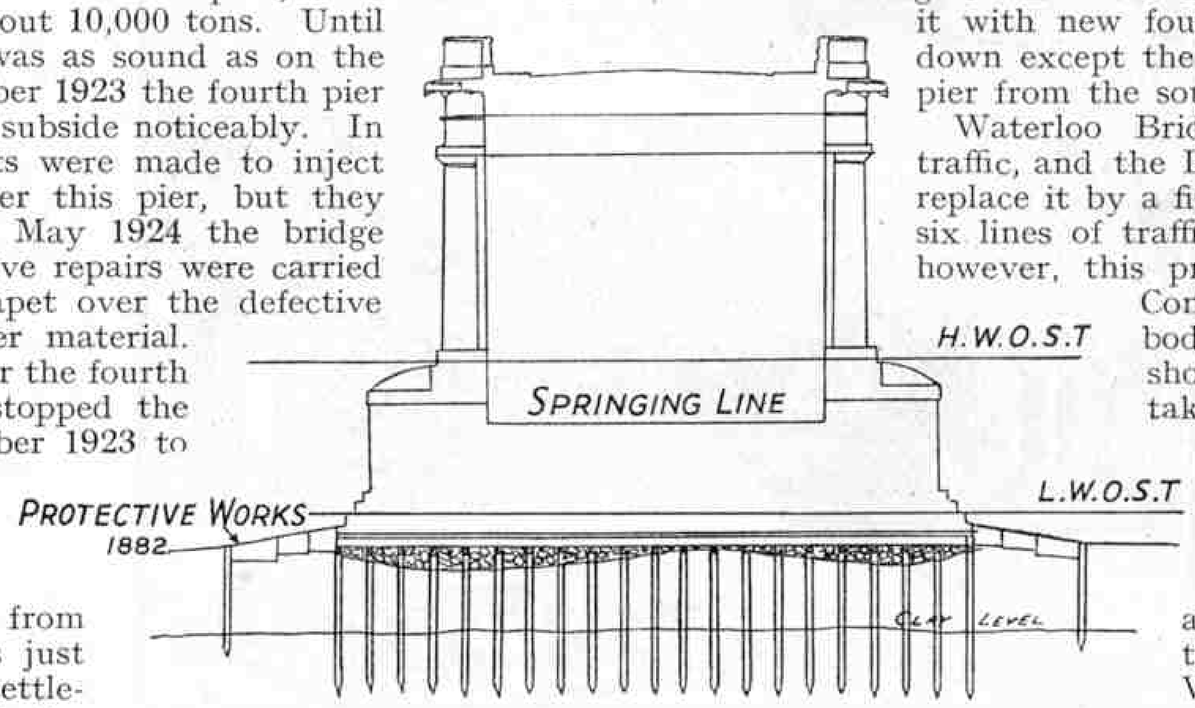


Diagram showing cross-section of one of the piers.

At the time the repairs were effected work was begun on the erection of a temporary steel bridge on timber supports alongside the old bridge. Good progress was made, and during May and June 1925 the bridge was again closed temporarily, this time to permit of the launching of the girders for the large or central span of the temporary structure. This huge span is 280 ft. long and weighs 500 tons, and its successful transfer sideways a distance of 93 ft. from the old bridge to the four concrete caissons provided for its support was a wonderful engineering feat. The span was put together on the old stone bridge, where it lay on bogies placed on rails laid along girders that stretched 93 ft. over the water. The work of moving the span was commenced by an army of 150 men at four o'clock in the morning, and steel hawsers working on winches pulled the span inch by inch across the gap.

Special means were provided for preventing the span from moving too quickly, and the proceedings were controlled by engineers at whose direction signals were given by means of whistles, the men up aloft responding by waving white and red flags. Steadily the enormous mass proceeded on its journey, and shortly after noon the task was accomplished, and the Union Jack was run up amid ringing cheers. It is interesting to note that the engineers found that the span had expanded $\frac{5}{8}$ in. between the coolness of the early morning and the heat of mid-day. The span was not placed immediately on to the caissons, but rested on rails about 10 ft. above. The task of lowering the span inch by inch into position was one of extreme difficulty, but it was accomplished on the following day without a hitch, when thousands of Londoners gathered on the banks of the Thames to watch the operations. The temporary bridge was opened to one-way traffic in August, 1925, the old bridge then being used for one-way traffic in the opposite direction, with a "dead slow" order over the defective part.

The actual cause of the subsidence of the piers is not definitely known. Some authorities ascribe it to decay of the piles, while others say that the tidal scour has removed some of the gravel from around the top of the piles, thus reducing their "grip" and hence their supporting power. In 1924 the experts of the London County Council expressed the opinion that the structure was worn out and dangerous, and therefore should be demolished. This recommendation raised a great outcry among those who were anxious to preserve the bridge on account of its architectural beauty, and because it is one of the masterpieces of Rennie; and other experts were consulted with regard to the possibility of giving the old bridge a new lease of life by repairing it and strengthening it while still preserving its distinctive features. Many eminent engineers among this second group expressed the confident opinion that the bridge could be saved by underpinning—that is providing it with new foundations—without taking anything down except the two arches abutting on the fourth pier from the south end.

Waterloo Bridge accommodates three lines of traffic, and the London County Council proposed to replace it by a five-arch bridge wide enough to have six lines of traffic. In view of the public protests, however, this proposal was referred to the Royal Commission already mentioned. This body recommended that the bridge should be reconditioned and widened to take more lines of traffic, and that a new bridge should be placed at Charing Cross. The Council then submitted to Parliament a scheme for the erection of this new bridge, but it was rejected; and therefore they reverted to their original scheme for a new Waterloo Bridge. Parliament again rejected the Council's plan, however, and put forward a scheme for reconditioning the existing bridge and widening it to take four lines of traffic, at an estimated cost of £685,000, towards which the Ministry of Transport was prepared to make a grant of 60 per cent. The Government plan was adopted, as mentioned at the beginning of this article, and the Council then appointed Messrs. Rendel, Palmer and Tritton, of Westminster, to be the engineers.

The work that was to have been undertaken in accordance with this reconditioning scheme includes the underpinning of piers Nos. 2, 3, 4 and 7, numbering from the north abutment. Arches Nos. 5, 6 and 7, and piers Nos. 5 and 6 were to be demolished and rebuilt. The foundation of every pier except No. 1, which forms part of the Victoria Embankment wall, and No. 8, on the Lambeth foreshore, was to be provided with an effective bearing area of at least 3,000 sq. ft. at a level 35 ft. below Ordnance datum.

The Sand-Blasting of Castings

A Fascinating Process in Weird Surroundings

ONE of the most absorbing centres of interest in a large engineering concern is its sand-blast system, and to the operators of the machines who are responsible for the smooth, glossy finish on the completed motor or generator belongs the major portion of this interest. Dressed in heavy overalls and leather apron, with their curious helmet, and air hose, hanging from the ceiling of their steel-walled room, they resemble a deep-sea diver at work in the treasure room of some sunken wreck, rather than a worker in an industrial plant.

In the shop foundry small castings that are to be freed of clinging particles of mould sand and rough edges are placed in a revolving drum, or tumbling barrel as it is called. In the bottom of the drum is a quantity of small, various-shaped pieces of scrap steel worn smooth from constant use, and when the drum begins to revolve these intermingle with the shifting castings and set in motion a cleaning medium. When the material is removed from the drum it is thoroughly cleaned by the friction, and ready for the machining department.

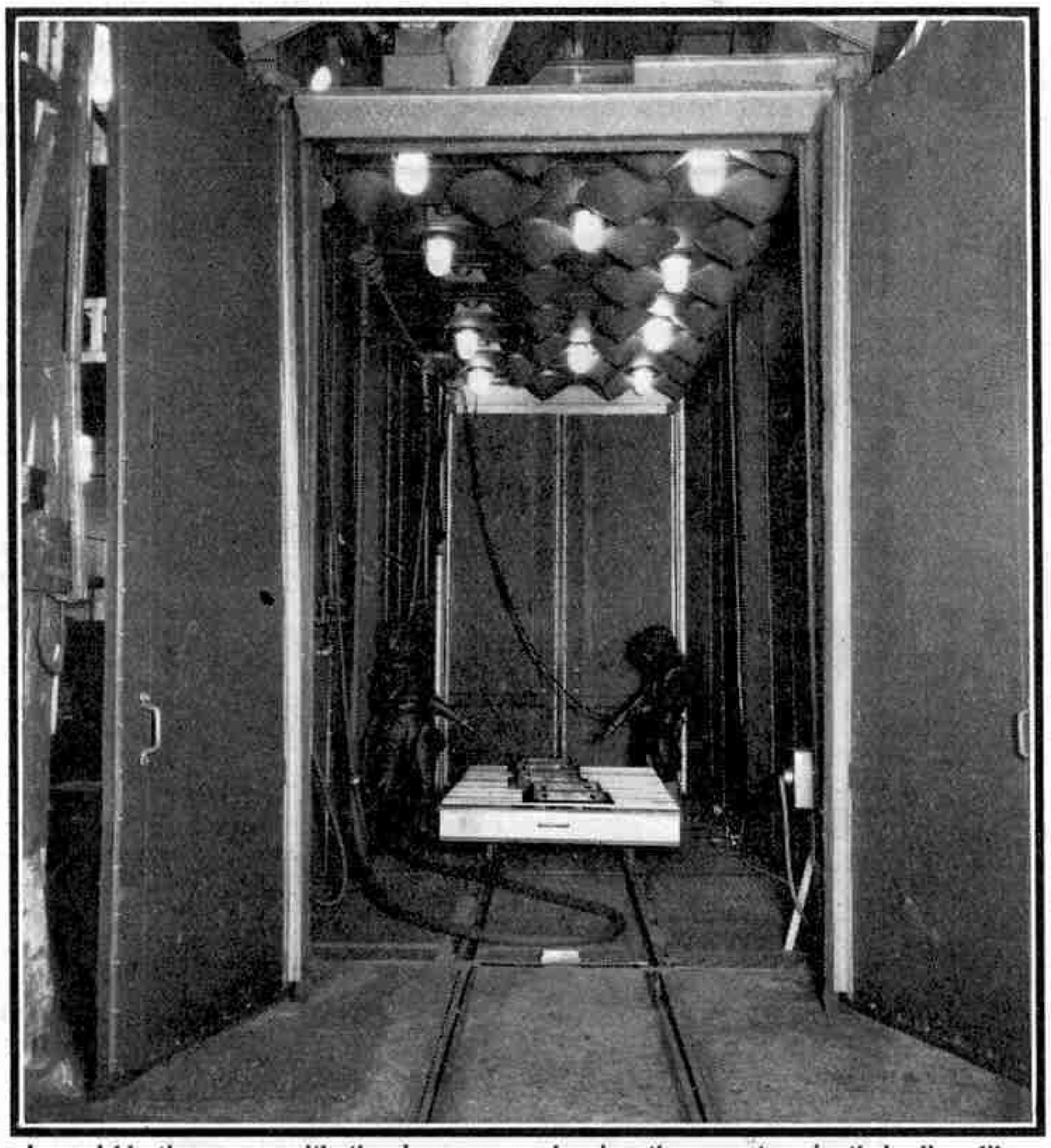
For cleaning large castings a different process must be used, as the size of a revolving drum in this case would be entirely prohibitive. The work is therefore passed to one of a number of steel-walled rooms in the plant, where it is subjected to a powerful stream of compressed air into which is introduced a steady supply of sand, varying in fineness according to the size and type of casting to be cleaned. This is the sand-blast operation.

The steel walls, ceiling and doors of the sand-blast chamber are vitally necessary for the protection of other workmen in the vicinity against the flying particles of sand. Similarly the operator within the room is guarded from the shower of driving sand by the peculiar but effective costume that he wears while spraying the castings by means of a heavy rubber hose with a special alloy steel nozzle necessary to prevent excessive corrosion by the constant flow of fast-moving sand.

The interior of the sand-blast room presents an odd appearance, the walls and ceiling bearing a dull-like finish caused by the glancing particles of sand. This dull appearance is offset by a number of frosted light bulbs in the ceiling that produce an evenly diffused light for the operator. These bulbs are constructed from special glass $\frac{1}{4}$ in. thick to prevent any possible breakage when the machine is in operation. The floor consists of perforated steel plates that permit the discharge sand to fall below into containers to be used over again. In the centre of the floor two tracks are laid for a small car that is used for moving the material in and out of the room. The tracks extend outside the room through two large doors, and add convenience to the handling of the castings, which are left on the car during the sand-blast operation.

After the doors are closed plenty of fresh air enters the chamber through a series of funnel-shaped ventilators in the ceiling. The ventilators are made with the apex of the funnel pointing downward, thus allowing the air to enter but preventing the flying sand from escaping. Cool air is introduced in the summer and keeps the room at a comfortable temperature. While the system provides ample ventilation, it does not protect the operator from the shower of sand and dust when at work, and for this reason it is necessary for him to wear the strange attire including the oxygen helmet. This outfit provides him with dual protection, insuring him against bodily injury, and from impurities in his respiratory system.

Of the numerous pieces of apparel worn, the helmet is the most interesting. It consists chiefly of an abrasion-resisting fabric somewhat similar to that of an automobile tyre, and it can be patched as easily as an inner tube if torn slightly. The helmet rests on the shoulders, and is cushioned with a thick layer of sponge rubber that acts also as an exhaust filter for the discarded air. It is held in place by straps down the back and around the waist. There is sufficient head and neck room inside without cramping, and outside vision is provided by an oblong glass window protected from the sand by a bulging, thin, wire mesh screen. The air hose leading from a connection inside the room branches into two special air-inlets at the operator's back, entering the helmet on each side at about the level of his chin. If the air leading to the helmet should accidentally be shut off, a supply would remain inside sufficient to allow the operator to loosen the straps and remove the helmet.



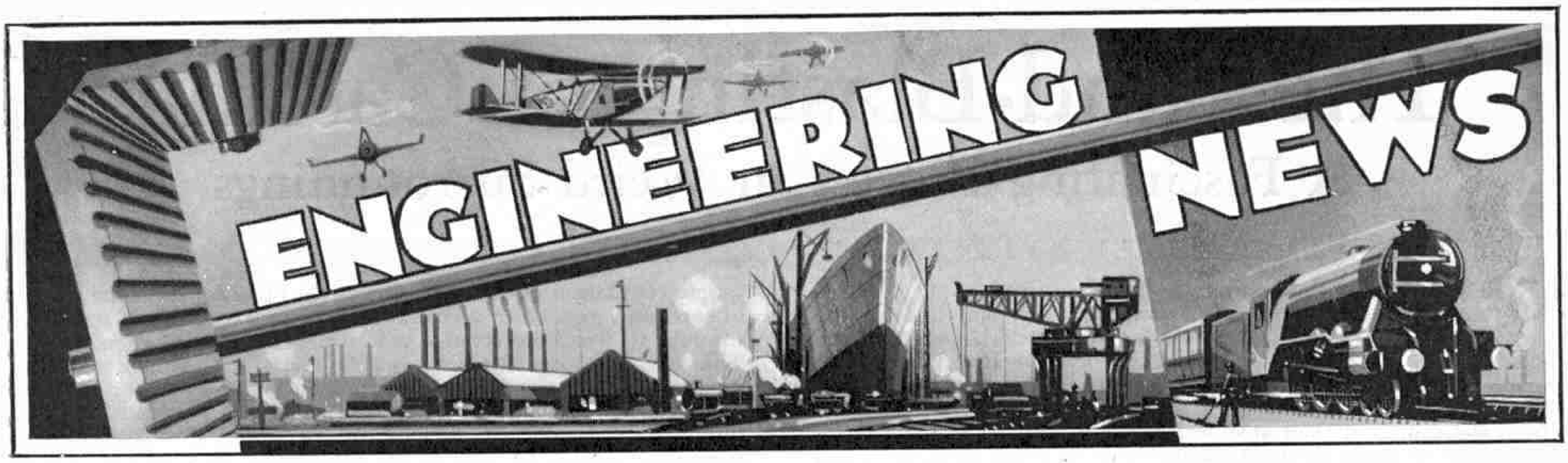
A sand-blasting room with the doors open, showing the operators in their diver-like costume. Photograph by courtesy of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, U.S.A.

The remainder of the protective suit includes a pair of overalls, over which is placed a heavy leather coat or apron, and suitable gloves to withstand the stinging effect of the blast of sand.

The air breathed by the operator is washed and filtered in passing through a glass purifier mounted on the outside of one of the steel walls of the room. Water can be seen bubbling actively in the glass bulb as the dirt and oil in the air is eliminated on its way to the helmet. Correct humidity and atmospheric pressure are also guaranteed to the operator, and the air by this time is purer than that circulating around the outside shop.

The actual sand-blast operation itself is no less interesting as viewed through a small window in one of the walls. The operator, after running the loaded car inside, closes the double doors and immediately dons his headgear and gloves, taking care that the correct amount of air is coming through his air hose and that it is not caught or tangled. He then opens the valve leading from the air and sand-mixing machine on the outside to the heavy hose with the nozzle. Instantly a powerful stream of sand is pouring against the castings. The operator slowly works the blast back and forth, and in and out of the castings, the sand gradually wearing off the dirt and rough edges. The process is more rapid than might be expected, for the sharp edges of the sand grains become powerful cutting tools under the force with which they are propelled.

By this time the interior of the room has become transformed into a veritable swirling sandstorm beating against the steel walls and sounding on the outside like hail. The operator is soon covered with dust, but is perfectly safe from the flying sand. Occasionally steel grit of various grades, or steel shot the size of air rifle shot, is required for large, rough castings, and when this is used the operator is extra thankful for his heavy apparel!



An Indian High-Voltage Line

An important new power transmission line is to be built from Erode to Trichinopoly in India. The line will be 82 miles long and will carry current at 66,000 volts; and will be supported by 600 lattice masts 52 ft. in height and spaced about 750 ft. apart. The line is being erected in connection with the Pykara hydro-electric scheme, one of the largest in the British Empire. The power station makes use of the waters of the Pykara River, the head of 3,080 ft. available being used to run three generator sets each developing 10,900 h.p.

New Suspension Bridge for Chelsea

After prolonged consideration and discussion designs have been prepared for a bridge across the River Thames at Chelsea to replace an existing structure that is not capable of meeting modern requirements. The present bridge, which is of the suspension type with three spans, is 75 years old, and cannot take loads of more than five tons; while the maximum width of the road at the suspension towers is 22 ft. The new structure also will be of the suspension type, and will have a centre span 332 ft. long and two side spans each 163 ft. long. The intervening piers and the abutments are to be of granite. The actual distance between the banks of the river at the point where the bridge is to be constructed is about 700 ft. The structure will be wide enough to carry four lines of traffic, and will cost about £480,000.

An All-Concrete Laboratory

An interesting example of the steadily-increasing application of concrete is provided by a new laboratory erected for the Tunnel Portland Cement Co. Ltd., of West Thurrock, Essex. Not only the building itself, but also the components of it down to desks, shelves and cupboards, have been made of concrete. In order to prevent the entrance of dust, of which the air in a concrete works is usually full, the numerous windows of the laboratory are fixtures, and air is fed into the building through special channels after passing through a washing plant.

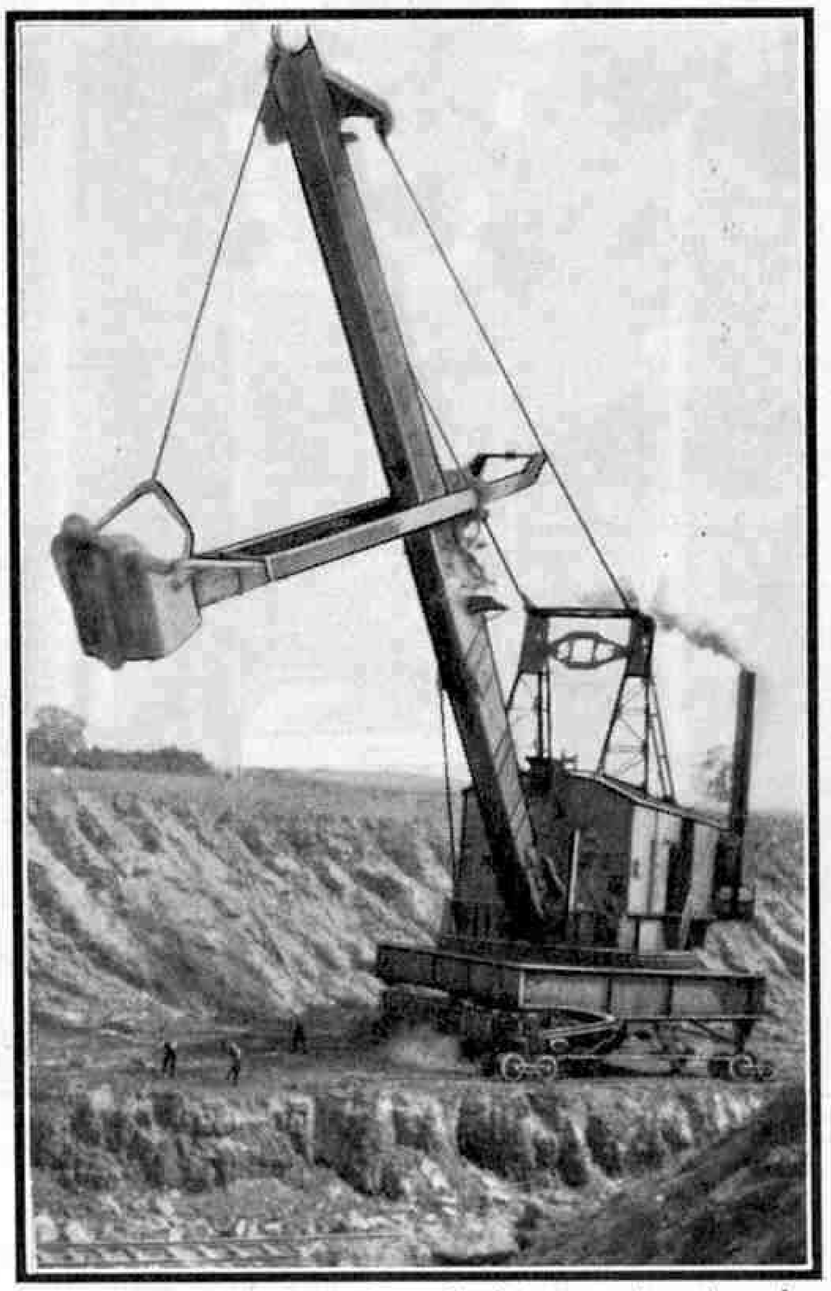
New Bridges in Stirling

Two new bridges have recently been built in the county of Stirling, one over the river Carson at Glensburgh and the other across the Firth and Clyde Canal at Dalgrain. The river bridge has five spans and has cost £35,000, while the other is of the steel girder type and has cost £10,000.

Making a Desert Fertile

When irrigation work now being carried out in a remote part of Central Asia is finished, it will make possible the reclamation and conversion to fertile cotton land of an arid desert 250,000 acres in area. The desert is in the Tadzhik Soviet Republic, and the work was begun several years ago. Part of the scheme is already in operation, the first water having been turned into the finished canals in the spring of last year. This made it possible for cotton to be sown in the spring of this year, and a total of more than 74,000 acres has now been brought into use.

It is not expected that the complete scheme will be finished for at least a year, but already the main canal, nearly 2,500 miles in length, and its floodgate, have been built. Some idea of the scale of the scheme is gained from the fact that the floodgate is 130 ft. in length and 36 ft. in height.



This illustration shows a huge bucket excavator at work. Some idea of its size may be gained by comparison with the people in front of it.

Canada's Most Powerful Tug

A powerful tug that has been constructed by a Quebec firm of shipbuilders for towing and fire fighting work is claimed to be the largest and most powerful tug in Canada. This vessel, which has been named the "*Citadelle*," is 127 ft. in overall length and is provided with propelling machinery developing 1,250 i.h.p. that gives her a speed of 12 knots. She is constructed wholly of steel and has been designed to enable her to operate efficiently and without damage in ice. This has been done by making the steel "frame" of the ship exceptionally strong, the keel and stem bars being of forged steel while the stern frame consists of a steel casting. Transverse frames made of heavy angle section are used from stem to stern of the vessel, being placed 21 in. apart except at the forward and aft ends, where they are 15 in. apart to afford additional protection against ice. The vessel is completely covered with steel plates, which are used also for the decks. All the steel that has been used in the vessel was rolled and supplied by Canadian mills except for the boiler-shell plates and furnaces, which were made in England.

The propulsion machinery of the "*Citadelle*" consists of a main unit that has a triple-expansion surface-condensing steam engine that normally runs at 130 r.p.m. Steam is supplied by two Scotch boilers arranged to work under forced draught. Each of these boilers is 11 ft. 9 in. in diameter and 11 ft. in length, and has a working pressure of 190 lb. per sq. inch. The fire fighting equipment consists of two pumping sets that are installed in the engine room and are each capable of pumping 2,000 gallons of water per minute. These supply water to three monitors, or "nozzles" mounted like small guns on supports; and on each side of the vessel are connections for four lengths of hose. The tug is normally in use at the Port of St. John, New Brunswick.

A Giant Trailer

A trailer that is probably the largest ever built, now in service at the Boulder Dam site in the United States, is 41 tons in weight and is capable of carrying loads up to 185 tons in weight. It is 37 ft. 8 in. in overall length, 22 ft. in overall width, and is provided with 16 wheels. Each of the wheels carries two tyres, and thus 32 in all are required. They are 28 in. by 14 in. in size. The trailer is used to carry heavy parts for the power station from the maker's works to a cableway that spans a canyon near the dam, a distance of 1½ miles.

Paddle Boats for Firth of Forth

Few paddle steamers are built nowadays, and therefore it is interesting to learn that two new Diesel-electric ferry boats that have been built by William Denny and Bros. Ltd., for the operation of a ferry service across the Firth of Forth, are driven by paddle wheels. The main reason for the selection of this means of propulsion is that a boat fitted with independently-driven paddle wheels is easier to manœuvre in narrow waters than a screw-propelled boat.

The new vessels, which are named "*Robert The Bruce*" and "*Queen Margaret*," are the first ships to be operated in British waters in which paddle propulsion has been combined with Diesel-electric drive. It was originally intended to fit steam machinery, but as the design developed it was found that it would be impossible to do so without extending engine and boiler casings above the main deck, which would have interfered seriously with the space available for vehicles. It was then decided to build the boilers at one end of the vessel, but it was found that even this would not make the car deck satisfactory, while at the same time it would introduce certain troublesome engineering problems. Finally, therefore, Diesel-electric machinery was decided upon.

Diesel-electric machinery is rather more costly than steam machinery of equal power, but on the other hand it is lighter, and is cheaper in operation for such a service as that in the Firth of Forth, in which the running time does not exceed 30 per cent. of the total service time. While the boats are lying at the piers the main engines can be stopped, which would not be possible with steam engines.

"*Robert The Bruce*" has accommodation for 500 passengers and "*Queen Margaret*" for 200. Both vessels are 149 ft. in overall length, 28 ft. in moulded breadth, and 7 ft. 10 in. in depth. They have a draught of 4 ft. 3 in., and a speed of 10 knots.

A New Bridge Opened in Burma

One of the largest bridges yet built in India has been opened at Sagainga, near Mandalay in Burma. It crosses the Irrawaddy River, the most important waterway in Burma, and is three-quarters of a mile long, with 16 spans. The bridge, which has been constructed to replace a ferry, carries a railway track with a 12-ft. road on each side. More than 10,000 tons of steel were employed in the superstructure, and the total cost of the bridge has been about £1,125,000.

A German Gas Grid

A gas grid scheme now operating in the Ruhr district of Germany is probably the largest of its kind in the world. The central gasworks for the scheme is situated at Magdeburg, in the heart of the manufacturing area of Central Germany, and the oven plant installed makes use of between 12,000 and 13,000 tons of coal per day. At present the plant consists of one battery made up of two units each having 30 retort chambers, but provision has been made for the installation of a second battery whenever it is required. Between the existing battery and the space left for the additional one is a huge coal tower capable of holding 3,000 tons of coal, which is fed by a cable railway that carries coal either from a bunker filled from railway trucks at an adjacent siding, or from a coal store.

The output of the Magdeburg plant varies between 65,000,000 and 100,000,000 cu. metres of gas per year, involving the utilisation of 400,000 tons of coal. The gas is stored in a gasholder with a capacity of 100,000 cu. metres. An interesting feature of this holder is that the bottom is used to store tar, which is one of the many important by-products of the plant.

Crushing 500 Tons of Ore an Hour

An ore crusher of the roll type in service at a new steelworks at Corby, Northampton, is capable of dealing with 500 tons per hour, and can take masses of ore up to 4 ft. 6 in. by 4 ft. by 3 ft., and if necessary even larger lumps. The rolls that crush the ore are made of steel with special studded shells. They are each 6 ft. in diameter and 5 ft. wide, and one is provided with two rows of heavy teeth in addition to the conical studs, to break up large masses of ore so that they can be dealt with by the conical teeth. The rolls are driven by separate motors at speeds ranging between 160 and 200 r.p.m., and when working at full speed the amount of kinetic energy stored up in them is sufficient to crush over 20 tons of ore before they are brought to rest.

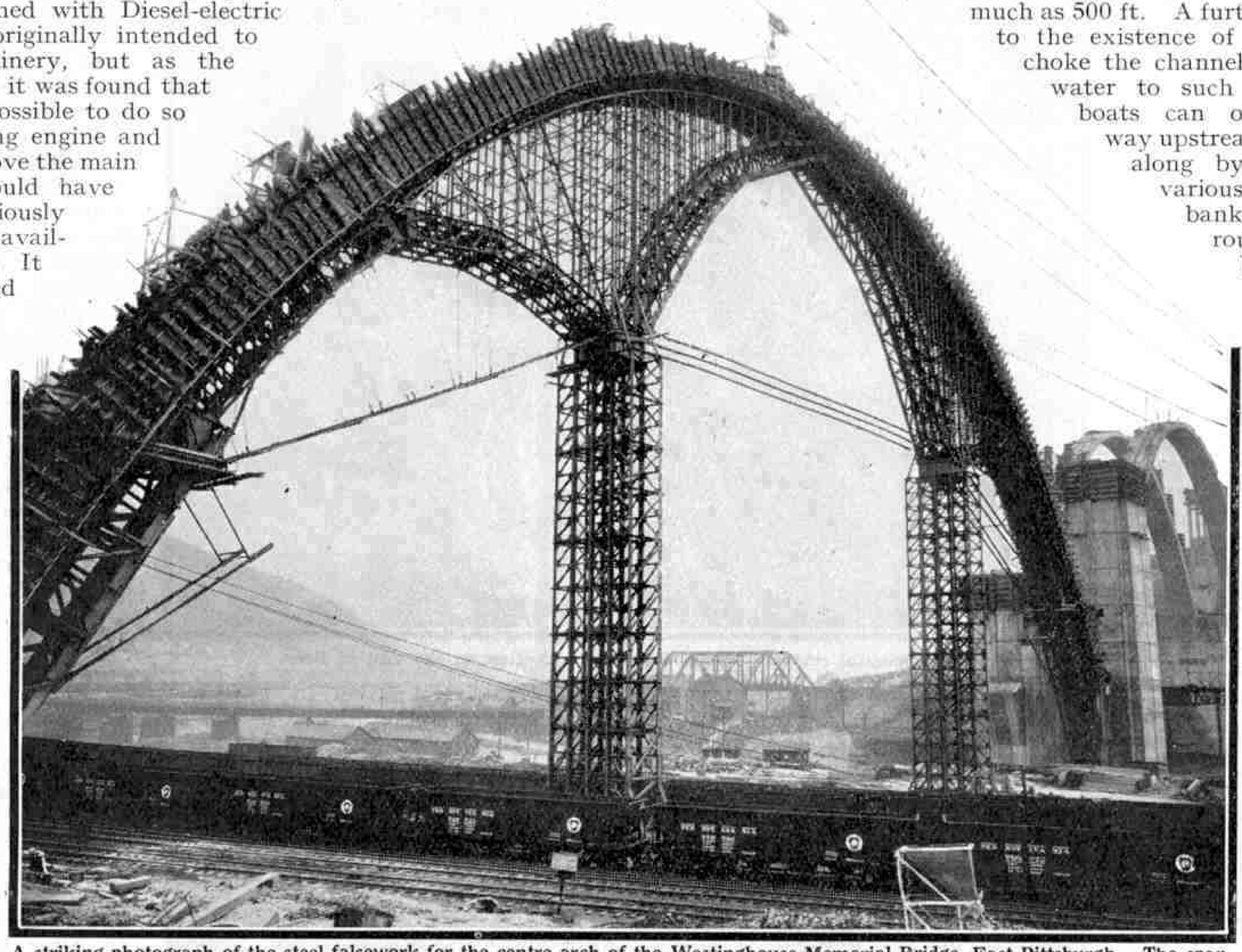
Clearing Rocks from Yangtze River

The establishment of steamer services on the Yangtze River in China has been seriously hindered by a gorge, about 30 miles from the important port of Ichang, where the river becomes so restricted that its velocity increases to some 8 m.p.h., and during floods caused by the melting of snow in the mountains the water level rises as much as 500 ft. A further trouble is due to the existence of huge rocks that choke the channel and disturb the water to such an extent that boats can only make their way upstream by being hauled along by ropes fixed to various points along the banks, and passed round capstans on board the boats.

From time to time attempts have been made to remove the worst of these rocks, but the work has been hampered by the fact that it can only be carried out during the few weeks when the water is low. The latest attempt to make the river more navigable was completed a short time ago when two huge rocks in the gorge were blasted away.

At the point where the work was carried out an island known as Great Pearl divides the river into two parts when the water is low, but is submerged entirely at flood time. It was decided to try to clear the channel on the south side of this island, in which the biggest obstruction consisted of two rocks close to one another, and estimated to weigh about 10,000 tons. Cofferdams were built over the tops of the rocks, being placed in position as the river fell and before the rocks were exposed. The area kept free for working by the cofferdams was about 16 ft. long and 12 ft. wide, and continual pumping was necessary. Shafts were then driven into the rocks, and eventually 130,000 sticks of gelignite and dynamite packed in petrol tins were lowered into position. This represented about 16,200 lb. of high explosive.

When the charge was fired, from a distance of about a quarter of a mile, the rocks were completely demolished, except for one small outcrop that was easily removed afterwards. An unforeseen and alarming effect of the operations was a huge wave of water that was set up when the charge was fired, and which swept over a local village and almost completely destroyed it.



A striking photograph of the steel falsework for the centre arch of the Westinghouse Memorial Bridge, East Pittsburgh. The span is 460 ft. long and is the longest concrete span in the United States. The building of this bridge will be described in a special article next month. Illustration by courtesy of the Westinghouse Electric and Manufacturing Company.

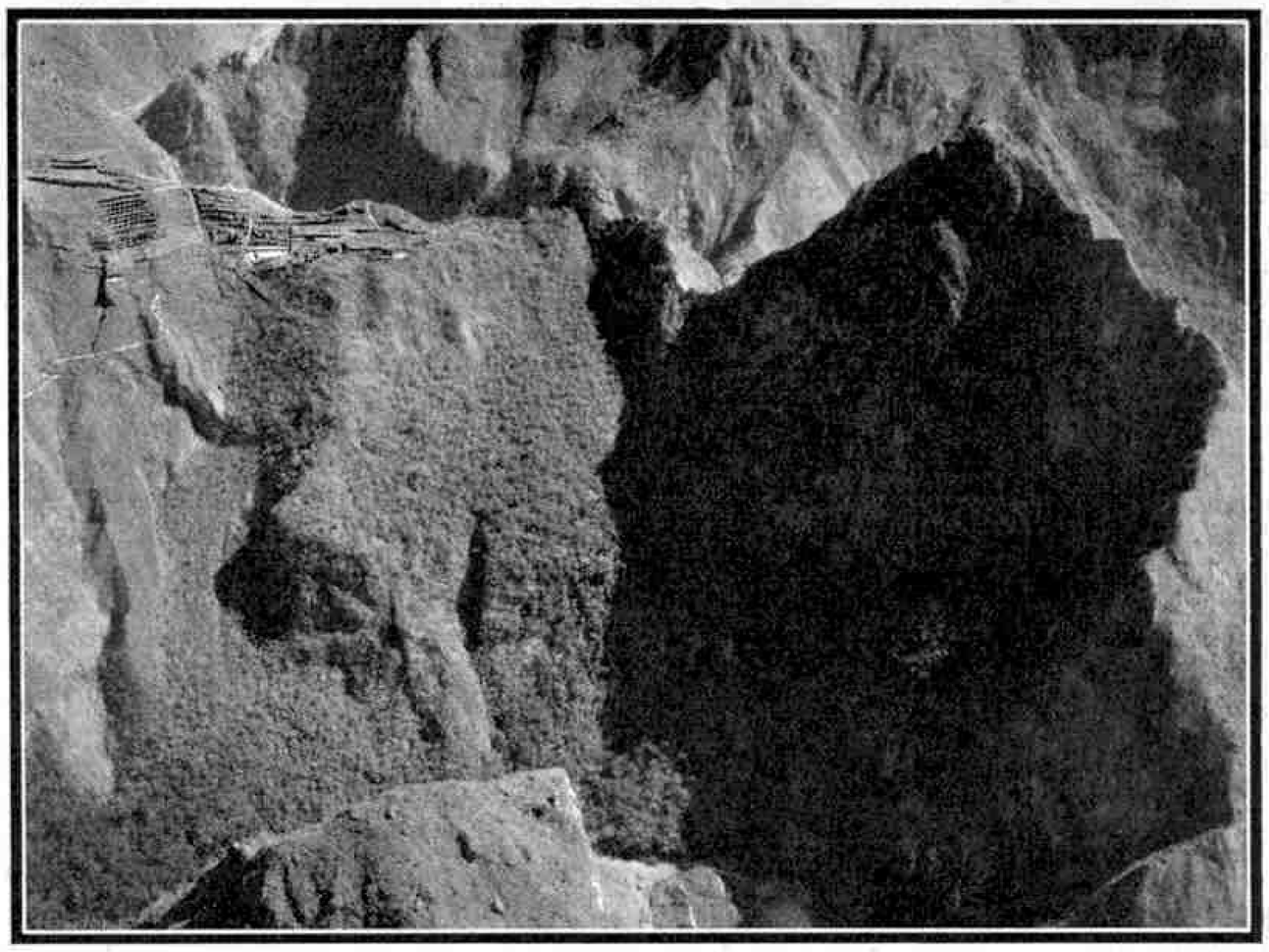
The Mysterious Sky City of Peru

By Lieutenant-Commander P. J. Searles, U.S.N.

TO reach Machu Picchu, the mysterious sky city of Peru, one takes a Grace Line "Santa" boat from New York heading for the West Coast of South America, preferably, if time permits, one that puts in at curious, unknown ports for exotic freight, "caucho" or crude rubber, "tagua" or ivory nuts, coffee, sugar, Panama hats, gold, vicuna wool and a dozen other things. Buenaventura on the Colombian coast with its daily temperature of 110° and annual rainfall of over 300 inches; attractive and clean Tumaco; picturesque Bahia de Caraquez tucked out of sight from the sea; Guayaquil, chief seaport of Ecuador; lonely, tiny Puerto Bolivar, hidden miles up a jungle river; Paita, one of the oldest settlements in Peru, well known three or four centuries ago to every freebooter of the Pacific; Salaverry, a few miles from historic colonial Trujillo and the bizarre remains of Chan Chan, both close enough for a hurried visit while the ship picks up cargo; Huacho perched up on a cliff, Talara, habitation of so many American oil men; Callao and fascinating Lima; Cerro Azul, stuck away on the coastal desert; add a few more ports to the list and get an idea of what a leisurely trip means.

The wonderful ruins of Machu Picchu, the mysterious sky city of Peru.

The ship is left at Mollendo, a port on the southern coast of Peru, resembling exactly one of our old-time desert mining towns. Going ashore is an experience. Of course it is perfectly safe, but one does wonder, looking at the rolling seas, why more passengers and baggage do not go overboard. Actually the "fleteros" are reliable and deliver their passengers safely ashore. At Mollendo one is two to four weeks out of New York, depending upon whether travel has been on a fast liner or on one of the slower vessels that stick their noses into more of the remote ports. An afternoon train, after traversing a rock and sand desert, past thousands of gigantic crescent-shaped sand dunes, crawling along the rims of tremendous gorges and chasms with small streams and minute but fertile valleys way down below, and sighting ancient ruins of forgotten civilisations, finally brings one at dusk to Arequipa, a picturesque old city of plazas and churches, quaint winding lanes and flowering gardens, tiled roofs and cobbled streets, all set in a rich valley 8,000 ft. above the sea, and with the surrounding magnificent Misti, Chachani and Pichu Pichu thrusting their snowy peaks 20,000 ft. up into the heavens.



The hill on which the city of Machu Picchu is perched rises sheer for nearly 4,000 ft. above the gorge of the Urubamba River.

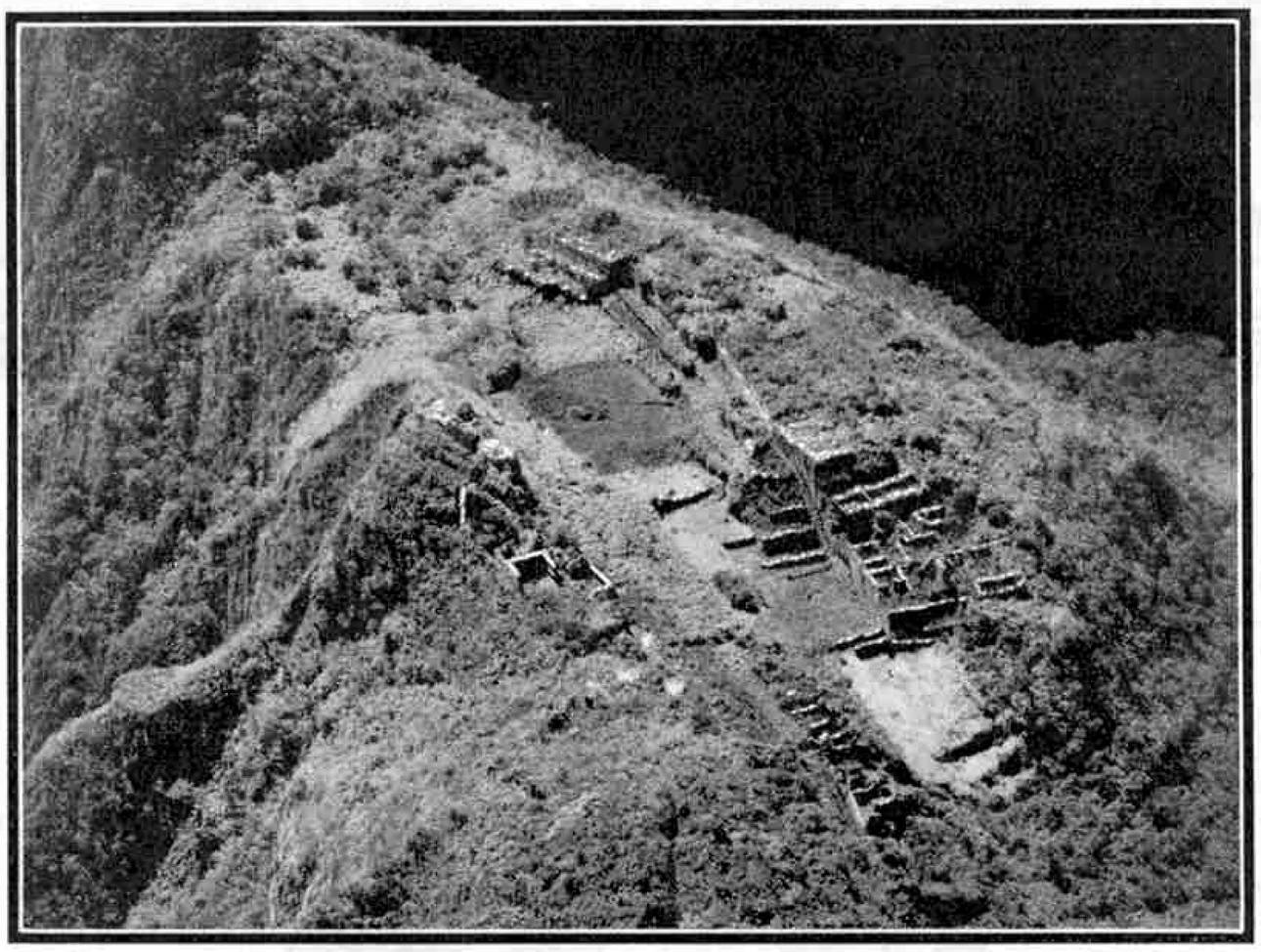
From Arequipa to Juliaca requires a long day by train, the railway gradually climbing higher and higher until at Crucero Alto it reaches 15,000 ft. After a night in Juliaca comes another day's ride to Cuzco. I must leave unsaid most of the thousand and one things that make Cuzco one of the unique cities of the earth. It is a city to explore for months, a veritable treasure-house for the archæologist, the antiquary, the student of living human beings, or the lover of sheer beauty. There is no such thing as modern Cuzco. The inhabitants must have stopped building shortly after the conquest, for hardly a structure seems to be less than three or four centuries old, and these are but infants compared to the magnificent walls, relics of the palaces and temples of the Incas, perhaps a thousand years old, which in turn are new compared to the immeasurable antiquity of Sacsahuaman, that monstrous, massive fortress overlooking the city. But we must travel on, following the Urubamba River by narrow gauge railway.

Climbing out of Cuzco in the cold, early morning we reached after an hour or so the celebrated pass a couple of thousand feet above the city, through which for unknown centuries have come millions of Indians to the markets of the capital, bringing tribute to Inca ruler or Spanish conqueror, carrying prayers and humble hearts to their gods enthroned in temples of silver and gold. Even to this day the Indian remembers the days of glory and as he comes through the pass and Cuzco in the valley below bursts upon his vision, he halts, raises his hand in salute, and cries, "Hail, holy Cuzco."

Once the heights of Cuzco had been passed we headed down the eastern slope of the Andes towards the head waters of the Amazon. For miles we traversed a pastoral valley with here and there a tiny village, and on all sides terraces, watch-towers, walls and other remains of a perished race. Towering mountains press in, the valley narrows and the river grows into a raging torrent fed from glaciers and snow in the mountain reaches high above. On each side are overhanging cliffs stretching vertically up a thousand feet or more. Now and then high up on a narrow side valley one glimpses a massive glacier, a waterfall or a snow-clad peak. The railroad ends, and the trail twists and winds downward toward the enormous savage jungles. We feel depressed

and remote in this wilderness of rock. At long last we reach a village of bamboo and mud huts. We have arrived, or so we think, at Machu Picchu, for a sign says so. But the hard labour was yet to come. Conversation and a display of money brought about the show of animals that I was assured were " caballos," and which, with the services of a small boy, were to cost about one American dollar.

As the horses appeared incapable of much exertion, and as we wanted to save them for uphill riding, we strode down the narrow trail on foot, followed by the small boy, the animals, and a collection of villagers who soon gave up the effort and returned to the somnolence we had disturbed. On we trudged, the tumbling river on our left, and on both sides enormous cliffs reaching up into the heavens. After several miles the boy took the lead and, turning sharply, led us over a tumbledown suspension bridge of lianas that spanned the Urubamba. On the other side he stopped and pointed up. We looked, expecting to see perhaps some odd rock formation. Straight up was an almost perpendicular cliff several thousand feet high, and looking like all others we had passed. Our faces must have registered puzzlement, for the boy in the most casual manner possible informed us that ancient Machu Picchu stood right on top of the cliff.



A striking view of the ruins, showing the heavy forest growth.

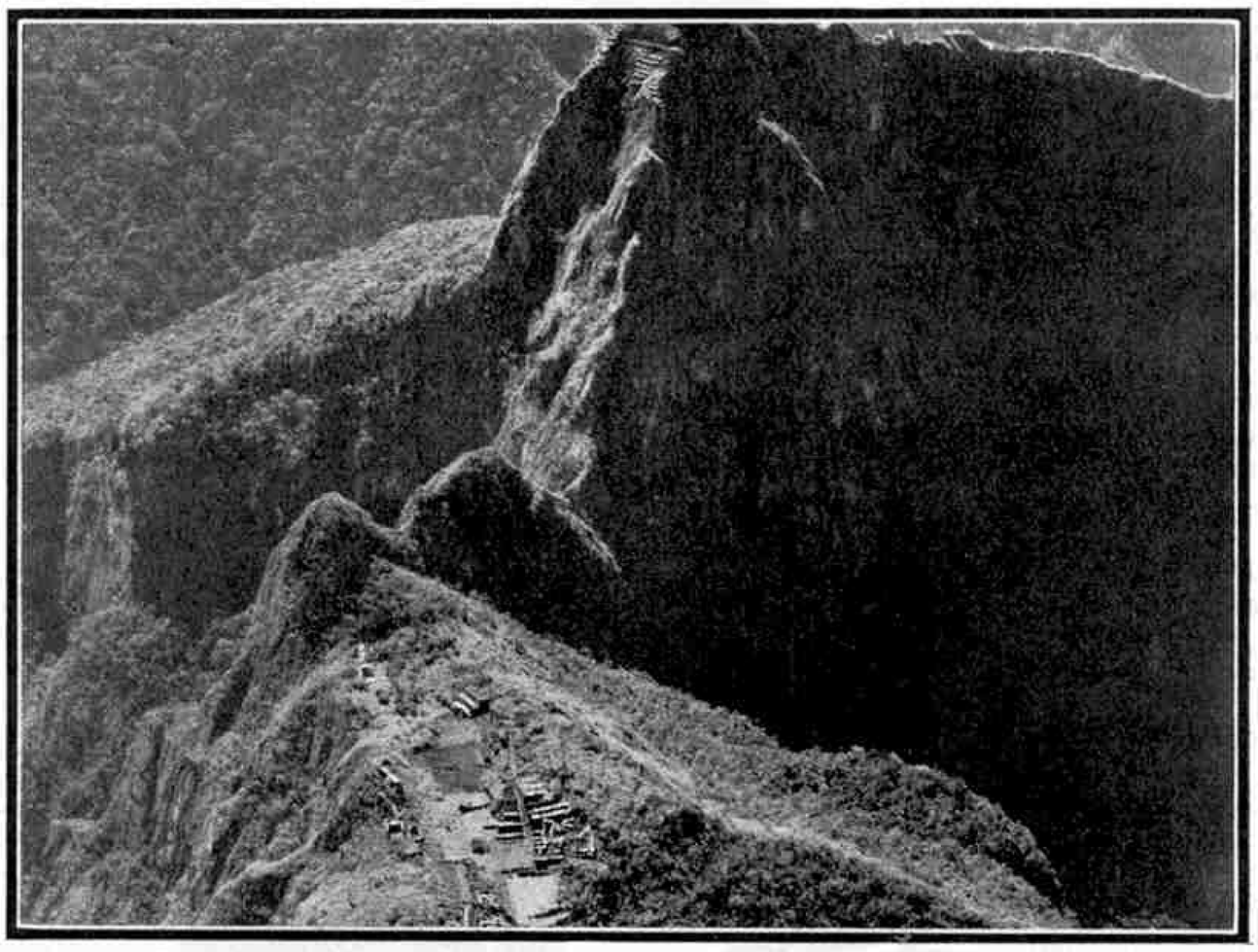
Machu Picchu is unbelievable. Picture the Urubamba River making a sharp and complete U-bend and thus enclosing on three sides an almost sheer cliff several thousand feet high, jutting out ahead like the sharp prow of a ship. At the top the cliff is almost a knife edge, sharp and steep, with one needle-like pinnacle thrusting its point up several hundred more feet. On all sides are towering mountains. Near by they are 10,000 ft. high, but in the distance they grow higher and higher until far off one glimpses the giants of the Andes. Close by the slopes are thick with trees and underbrush; farther away the upper parts of the mountains are bare rock; and still farther in the distance the peaks are covered with snow and ice that burn and dazzle like diamonds in the brilliant sunlight. Here and there is a glimpse of a magnificent glacier ever fed from the eternal snows. Here and there is a waterfall, sometimes clear and distinct, sometimes partially veiled by spray and delicate fleece of clouds. The scene is overpowering in its grandeur and immensity. All is magnificence and glory. Only a lonely condor relieves the solitude, barren these many centuries of human life.

Stretched along the narrow top of the cliffs that spring up from the river so far below are hundreds of houses, temples, fortifications, watch-towers, fountains and pools, storehouses and granaries—all the buildings of an ancient city. One behind the other they are perched, row upon row, each a fortress in itself and each a residence for an unknown people. They are jammed closely together and face on one or more of the numerous short lanes that traverse the city. All are one storey in height and have but one or two small rooms. I imagine there could not have been much household furniture in those ancient days, for in the walls are built seats and longer rest spaces that probably were used as beds. The bare stones most likely were covered with skins of wild animals killed in the jungles below, or with blankets made from the feathers of birds. As in other Inca ruins, walls, doors, niches, etc., decrease in size towards the top.

Some of the buildings undoubtedly served as temples, and the city itself more or less centres about the plaza containing a temple and the dwelling of a priest. The sun, of course, in essence was the deity of the ancient peoples of Peru, and it is not difficult to visualise the pleasure with which the first rays were greeted as they came over the mountain tops each morning, thrusting into the temples, waking and warming the people. Machu Picchu is only about 15 degrees south of the Equator, but its altitude carries with it perpetual chill. As one indication of the importance or predominance of the sun in their pantheon I mention the massive " intihuatana " or sun-dial, a boulder carved into an upright stone shaft set on one of the highest points of the city.

Machu Picchu is heavily fortified. I must confess that I cannot understand the reason for fortresses, for it seems to me the best thing to have done to invaders would have been to roll rocks on them as they clambered up the precipitous slopes, and then capture those few who reached the top as they lay exhausted from the climb. But there the forts are, massive structures of heavy stone, with parapets around the tops and openings for hurling out stones or lances. Walls almost surround the city. Actually the place must have been impregnable. We have no records of its capture, but this is due to the fact that we have no records of the city at all.

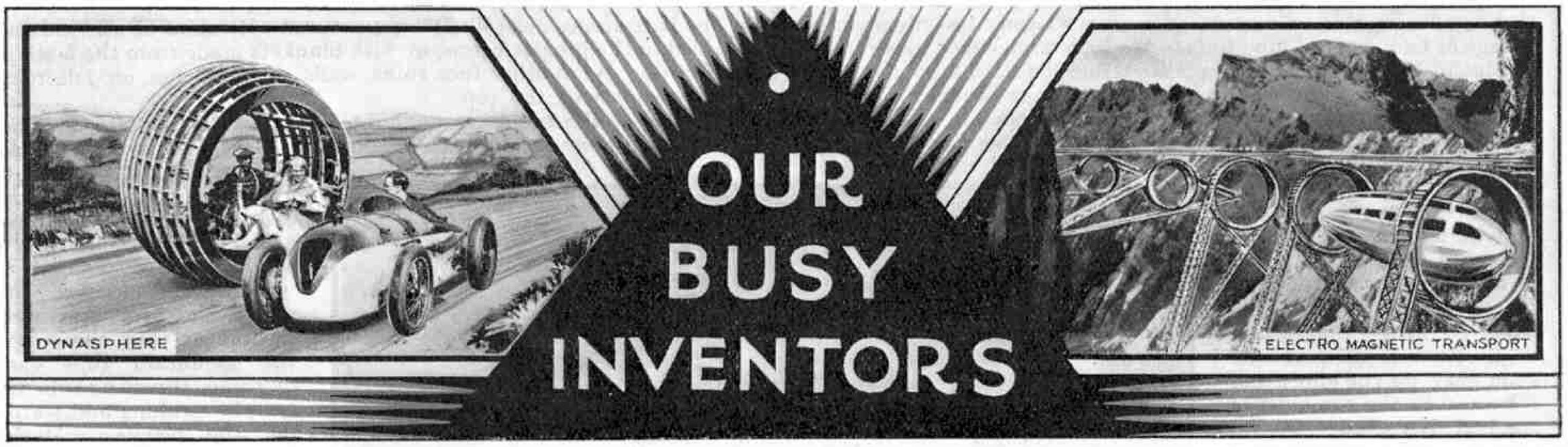
Most interesting are the channels and pools for the flow and storage of water. Rain, as it fell, must have been captured in small basins on the upper slopes of the ridge, and then led through stone troughs down to the city. Each trough empties into a pool cut in the living rock, and the pool in turn overflows into a second trough or channel that leads the water to another pool a few feet lower. I suppose the pools were used for what washing and bathing there was, for cooking, drinking, and the like.



The entire city is of white granite, weathered through the centuries to grey.

The entire city is built of a white granite that has weathered to an exquisite light grey. The stonework is really astounding. It is not quite so fine as some of the marvellous walls of Cuzco, nor so cyclopean as Sacsahuaman; but it does represent a very high culture. Some huts on the outskirts of the city are of crude, dry rubble, but the majority of the buildings are of cut stone beautifully jointed. Most surprising is the stonework of the circular watch-towers. How anyone without hard metal tools could have cut rock to a curve and fitted one stone to another so perfectly remains a mystery. All through the city every boulder or ledge is employed, so that at times it is hard to distinguish between natural and man-made objects. Much of the street paving and stairways are cut from living rock, and in one place there is a series of seven steps cut from one solid piece.

Who built Machu Picchu? When? Why? Several archæologists believe the city was built as a refuge for the (*Continued on page 500*)



By P. A. Tent

ONE of the most remarkable features of modern industry is the widespread use of synthetic resins. The plastic materials made from them can be moulded to any shape when warm, and as they are insulators, and can be coloured and given artistic finishes, new openings are continually being found for them. In spite of their obvious possibilities, I was scarcely prepared for their conversion into a substitute for putty. An American company is now mixing wood with a synthetic resin, however, to form a material that sticks like glue and is superior to the real thing in that it does not shrink or pull away from the surrounding wood when it is used in glazing. In fact, when wood in contact with the synthetic putty is planed, the constituents are firmly bound together in the shavings.

Speeding Up Telephone Calls

An ingenious device that has just come to my notice shows how keenly interested inventors are in gadgets that save time and labour. It is designed for use with the automatic telephone, now familiar to so many of my readers, which itself was introduced to reduce the time required to make a telephone call. The short time required to dial any given member has proved too much for one inventor, and he has worked out this interesting mechanism to enable the number of operations necessary to be reduced to two when dealing with selected numbers that are often required. The invention has the additional advantage of making it unnecessary to remember numbers of this type.

The new device is called the "Autodial," and is illustrated on this page. The upper illustration shows the Autodial itself. When it is installed, the names of the subscribers most often in demand are written or typed in spaces provided for them on the card inserted in the top of the box. When one of the individuals or firms represented is wanted, the indicator is moved to point to the name, and a mere pressure of the thumb on the lever in front then effects the necessary dialling. If the number is engaged, it is only necessary to wait for a short time and to depress the lever once more, for the Autodial remains set to call the number already selected.

The secret of the invention is revealed in our second illustration, from which it will be seen that several discs are mounted on a central axis, one disc being assigned to each of the subscribers dealt with. These discs are rotated when the lever is depressed, and the serrations on their circumference are so arranged that their movement carries out the necessary dialling operations. The indicator on top of the Autodial serves to bring the dialling mechanism into contact with the appropriate disc.

The Autodial can be fixed to any automatic telephone installation and does not interfere with ordinary use of the instrument. It will be of special value in making emergency calls, for fumbling due to excitement or nervousness can lead to serious delays in calling a fire brigade, the police or an ambulance station with an ordinary dialling instrument.

The Autodial, a device to save time and trouble in using an automatic telephone. The photographs on this page are reproduced by courtesy of Dictograph Telephones Ltd.

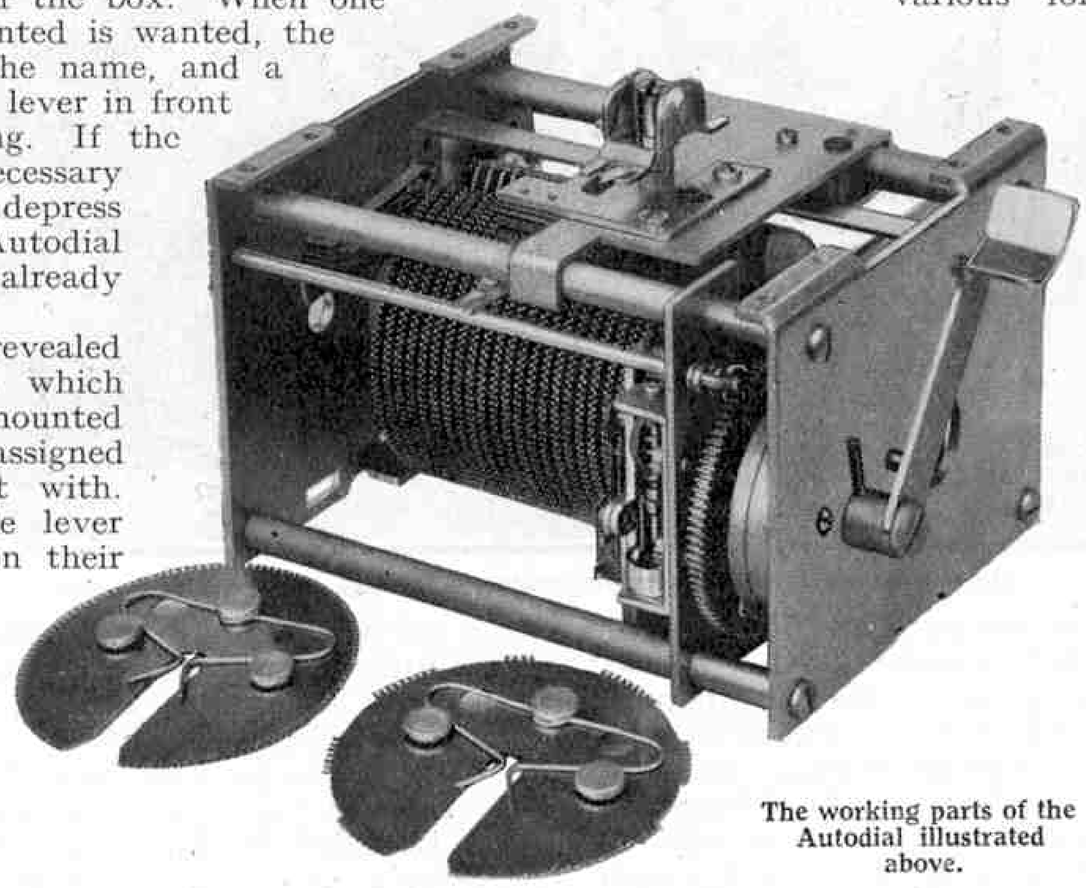
Another device that seemed to leave little scope for the inventor is the electric bell, but even here it seems that there is room for improvement, as the introduction of a new loud ringing type shows. In this the gong is struck by a steel ball that is driven sharply against its inner edge. The ball is placed in a short vertical tube, in which it can rise and fall. Below the tube is a horizontal plate that can be rotated at high speed by means of an electric motor, and at every revolution a steel ball fixed in the plate strikes the movable ball and hurls it to the top of the tube, where it comes into violent contact with the rim of the gong, which fits over its casing. The motor runs at 4,000 r.p.m. and can be operated by means of current from a battery, or from either D.C. or A.C. mains.

The gong of the new type of bell, which has been developed by Siemens and Halske A.G. in co-operation with the Berlin Fire Brigade, is mounted in such a manner that the distance of its rim from the striker can be varied in order to alter the loudness of the ring. The bell is intended for use as a fire alarm, and also on railways, and in mines, factories and other places where a really loud noise is required.

Photographic Flashlamp for Amateur Use

Many photographers have made use of the photographic flashlamp, which gives a brilliant flash without producing the dense smoke that marks the firing of magnesium in its various forms. This lamp was described in "Our Busy Inventors" at the time of its introduction, and now it has been succeeded by a small one designed especially for amateur use. Both types contain a quantity of extremely fine aluminium foil crumpled round the filament of the lamp, and are filled with pure oxygen. As soon as current is passed through the filament the foil burns rapidly, and develops so much light that subjects at distances up to 12 ft. can be photographed satisfactorily on fast films. The flash is both noiseless and smokeless, and is timed to last for one-fiftieth of a second.

The new photographic flashlamp is only as large as an ordinary 40-watt lamp, and a flashlamp battery of three volts is sufficient to operate it, although house current also can be used. It is of handy size for packing and carrying.

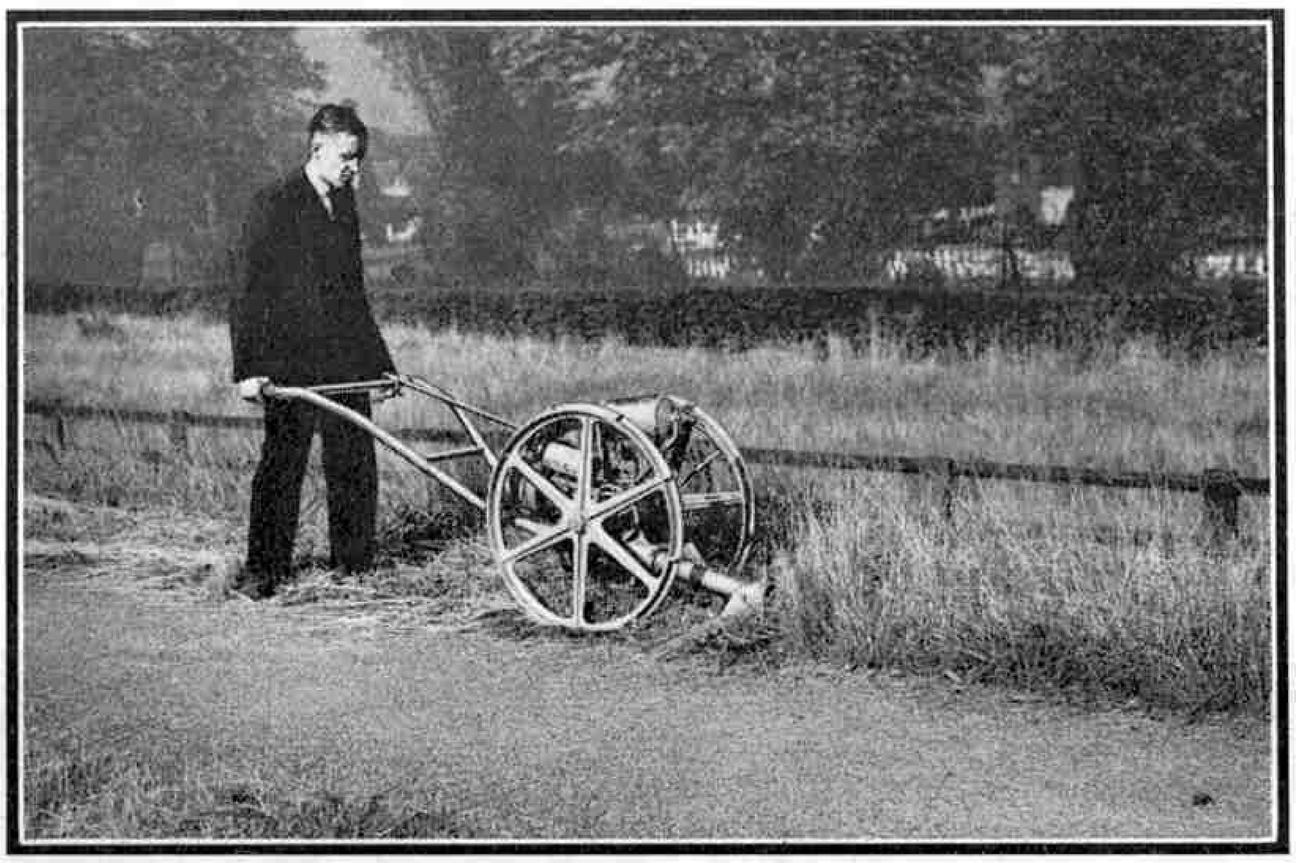


The working parts of the Autodial illustrated above.

Those of my readers who are keenly interested in model making and in model engineering work will welcome a new solder pot, introduced by W. T. Henley's Telegraph Works Co. Ltd., that can readily be fitted to their "Solon" electric soldering iron by means of a metal strap and two screws. So long as the soldering iron is in use, scraps of solder placed in the pot are kept in a molten state, and can readily be poured on to the work by means of the lip provided. The device is economical, for many scraps of solder that otherwise would be wasted can be melted up in the pot, and its advantages make its price of one shilling appear very small.

A Petrol-Driven Scythe

In spite of the existence of many sizes and types of mowing machines, there remain many places where it is necessary to resort to the scythe for cutting grass. For instance, a machine of the ordinary type is useless for dealing with long coarse grass in corners of parks and plantations, or at the sides of roads, and for such purposes what is described as a motor scythe has been introduced by John Allen and Sons (Oxford) Ltd. An illustration showing this ingenious device in use is reproduced on this page. The machine is self-propelled, and is simply controlled by means of a clutch and the throttle of the petrol engine by which it is driven, the grass being cut by serrated knives similar to those employed on agricultural mowing machines and harvesters.



The "Allen" Motor Scythe in action. Photograph by courtesy of John Allen and Sons (Oxford) Ltd.

When in use the "Allen" motor scythe travels at a comfortable working pace and is very easily steered, while there is no difficulty in keeping it in good condition, for the cutting blades can be sharpened when required by means of an ordinary file.

Thermometers Baked in High Temperature Ovens

The measurement of temperature provides many illustrations of the need for inventive thought in securing increasing accuracy in highly technical work. An interesting example is the development of a thermograph, or temperature recorder, for use in conveyor ovens, through which tin plates and enamelled metal objects are passed on endless travelling metal belts. Ovens of this kind are employed in the Meccano factory for baking the enamel on Meccano parts and on Hornby locomotives and other products. Thermometers placed at various points do not give an accurate indication of the manner in which the temperature of any part changes as it passes along the belt carrying it through the ovens. A recording thermometer travelling with the part itself is necessary for this purpose, but the clockwork movement of an ordinary thermometer of this type cannot withstand the high temperature to which it is subjected.

Thermograph or recording thermometer for use in conveyor ovens. Photograph by courtesy of Messrs. Negretti and Zambra.

Messrs. Negretti and Zambra, the well-known scientific instrument makers, have solved the problem by making a thermograph in which the clockwork recording mechanism is fitted in a chromium-plated polished aluminium cover containing insulating material about 2 in. in thickness. The instrument is placed in the oven along with the articles of which a complete temperature record is required, and so efficient is the insulation that after exposure to a temperature of 500 deg. F. for an hour, the clockwork mechanism itself is only at a temperature of about 150 deg. F.

The thermograph is of great interest. The temperature to be recorded is taken up by a steel bulb attached to the instrument by means of steel capillary tubing. The bulb and the capillary tubing are filled with mercury under high pressure, and are in communication with a Bourdon tube, also filled with mercury. The Bourdon tube is an improved form of that employed in the pressure gauges mounted on boilers. It alters its shape when the pressure of the mercury in the steel bulb increases with rise of temperature, and its movement then causes a pen to rotate in the same manner as the pointer of a pressure gauge is rotated. The pen of the thermograph does not move over a scale, however. Instead it makes a continuous line on a chart that is rotated at constant speed by means of clockwork mechanism, and from the line the temperature to which the instrument has been exposed at any moment while in use can be read directly.

Daylight Lighting

Electric lamps and electric lighting continue to attract the attention of inventors, who are striving to give us what I may call artificial daylight and also to devise more efficient means of lighting than those now in use. The lamps that appear to give most promise of reproducing daylight are the lamps, previously referred to in these columns, in which a luminous glow is obtained by passing a discharge of electricity through a mixture of gases and metallic vapours. Unfortunately those already in use have proved deficient in red rays, and the colour values of objects illuminated by them have therefore not been accurate, blues and greens being most prominent and reds appearing dingy brown. A new type of discharge lamp has now been invented by a member of the research staff of Siemens Electric Lamps and Supplies Ltd., in which these disadvantages are overcome. Under its light articles are shown in their natural colours and it has the further advantages that there is little blackening of the bulb, and alternating current supplies of 200 volts and upwards can be used. At present the lamp is suitable for lighting streets and the interiors of large buildings, but no doubt further progress will result in the production of a lamp of more universal application.

In the meantime the efficiency of the ordinary gas-filled lamp has been increased by the introduction of a new filament. This is made of tungsten, as in the lamps now used, but takes the form of a double spiral that has led to the use of the name "coiled-coil filament" lamp for the new product. Its efficiency is much greater than that of ordinary lamps, and the improvement is most marked in the lamps of 100 w. and less that are employed in lighting our homes. Coiled-coil filament lamps have been on the market on the Continent for several months, and it is hoped that the experiments now being made in this country with the new type of filament will lead to their introduction here, possibly next Autumn.

Bath and Radiator in One

A simple invention that if developed commercially will appeal to many readers of the *"M.M."* is a bath that also is a radiator and towel drier, and in which the water keeps hot for a longer time than in one of the ordinary type. The upper part of the sides of the new bath forms a water jacket that can be filled with hot water when required, any overflow from it finding its way into the bath itself. Two ingeniously placed taps give complete control of the hot water supply to both the bath and the radiator, and it is said that the warm radiator provides a very comforting headrest for those who enjoy prolonged "stewing" in hot water!

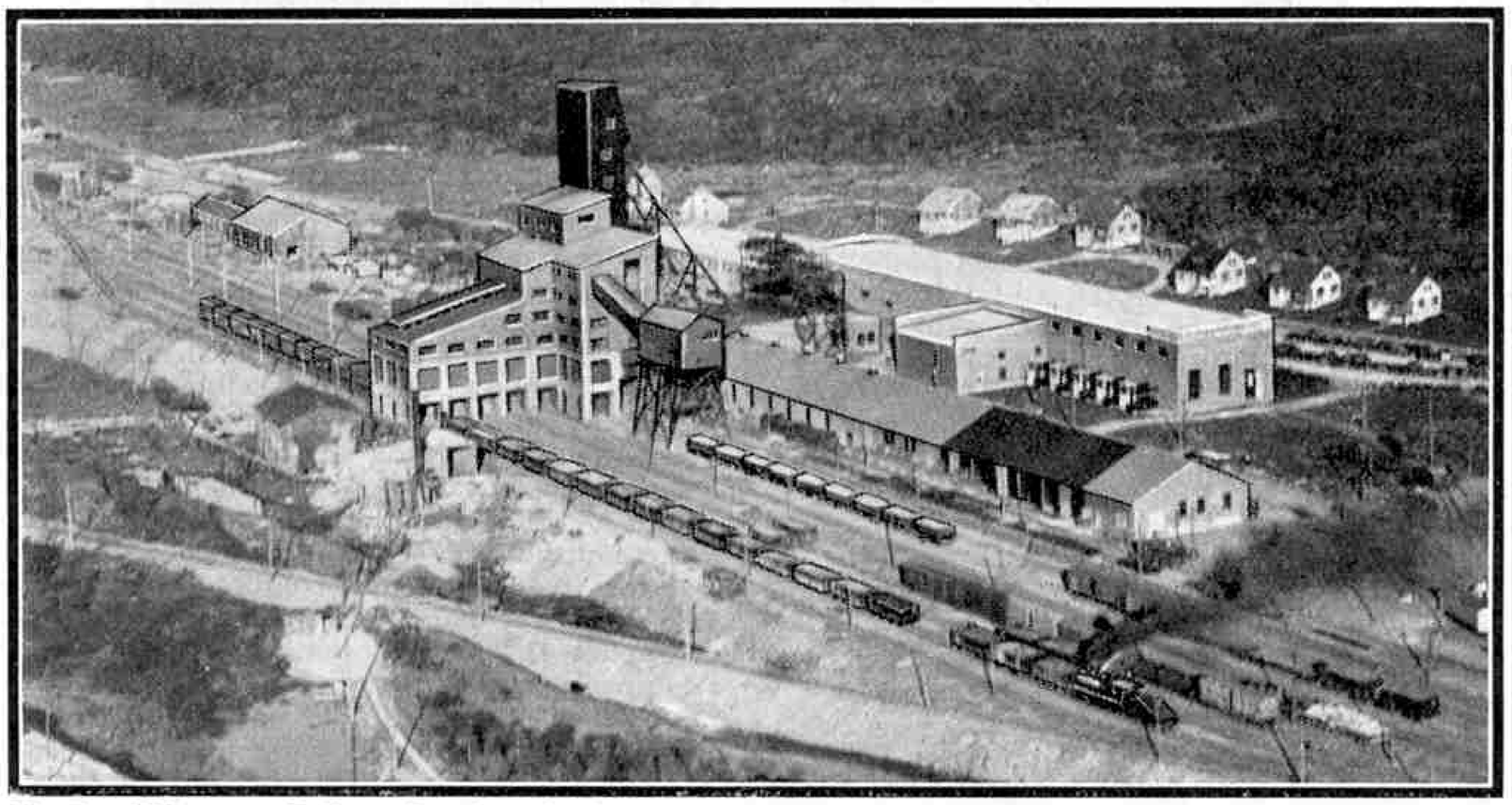
I was interested to see that the bicycle aeroplane has again made its appearance, this time in France, where an inventor has fitted wings and a propeller to his machine. He has already obtained high speeds on the road and hopes soon to make short flights.

The Story of Nickel

From the Mined Ore to the Refined Metal

NICKEL is a "young" metal in comparison with gold and silver, two of the earliest metals to be discovered. The first people to make use of nickel were probably the Chinese, who were familiar with it only in the form of an alloy, to which they gave the name of "*paktong*," meaning white copper. This alloy was highly valued by the Chinese on account of its suitability for the manufacture of the gongs that played so prominent a part in the daily activities of their temples. During the 17th and 18th centuries large quantities of *paktong* were exported from China to Europe, where it was used as a substitute for silver.

We know also that nickel was used at a very early date by the Bactrians, a people living in Central Asia. The province of Bactria, or Balkh, was at one time of great importance, and its capital formed the centre of a thriving commercial intercourse between India, Persia, China and Central Asia. Coins used in 235 B.C. by Euthydemos, King of Bactria, have been carefully analysed and shown to contain over 20 per cent. of nickel, together with some 77 per cent. of copper and a small proportion of various impurities. Bactria, it may be mentioned, gives its name to the Bactrian two-humped camel, which is less swift than the one-humped Arabian camel or dromedary, but it is hardier and is less sensitive to cold.



The Frood Mine, near Sudbury, Canada, which is sunk to a depth of 3,100 ft. This photograph is reproduced by courtesy of the International Nickel Company, Inc., New York.

During the Middle Ages copper and silver were mined extensively in the Erzgebirge, a mountain range separating Bohemia and Saxony. During their operations the miners encountered from time to time deposits of a reddish coloured ore that, to judge from its appearance, was rich in copper. The deposits also possessed a certain brilliance suggestive of silver. This strange ore was found in abundance in the neighbourhood of the mining town of Schneeberg, and the miners firmly believed that they had discovered a new source of mineral wealth. Then came bitter disappointment. Every method for the extraction of copper known at that time was tried with the mysterious ore, but without the slightest success. All that the processes yielded was a mass of unpleasant grey metal so brittle that a blow from a hammer would smash it into fragments. The intractability of the ore naturally exasperated the miners, and they gave it the name of "kupfernickel," or "coppernickel," the word nickel meaning practically the devil, otherwise "Old Nick!"

The strange ore abandoned in disgust by the Saxon miners was eagerly investigated by scientists, but nickel was not isolated until 1751, when a Swedish metallurgist named Cronsted succeeded in obtaining a small quantity of the metal from ore mined at Helsingland, Sweden. It took Cronsted five years of patient experiment to achieve this success, and although the resulting metal was very impure, he proved that the ore could be worked. It was not until four years later that comparatively pure metallic nickel was produced, and further prolonged research had to be carried out before the first really pure nickel was eventually obtained in 1781.

When the valuable qualities of the metal had been established, commercial refining operations were commenced about the year 1824 in London, Saxony and Hungary. About this time rich deposits of nickel ore were discovered in Norway, and this proved the most abundant source of supply during the next 40 or 50 years. In 1865 important deposits were discovered in the Pacific Island of New Caledonia. It was not long before the island became a serious rival of Norway, and until towards the close of the century New Caledonia was the chief source of nickel.

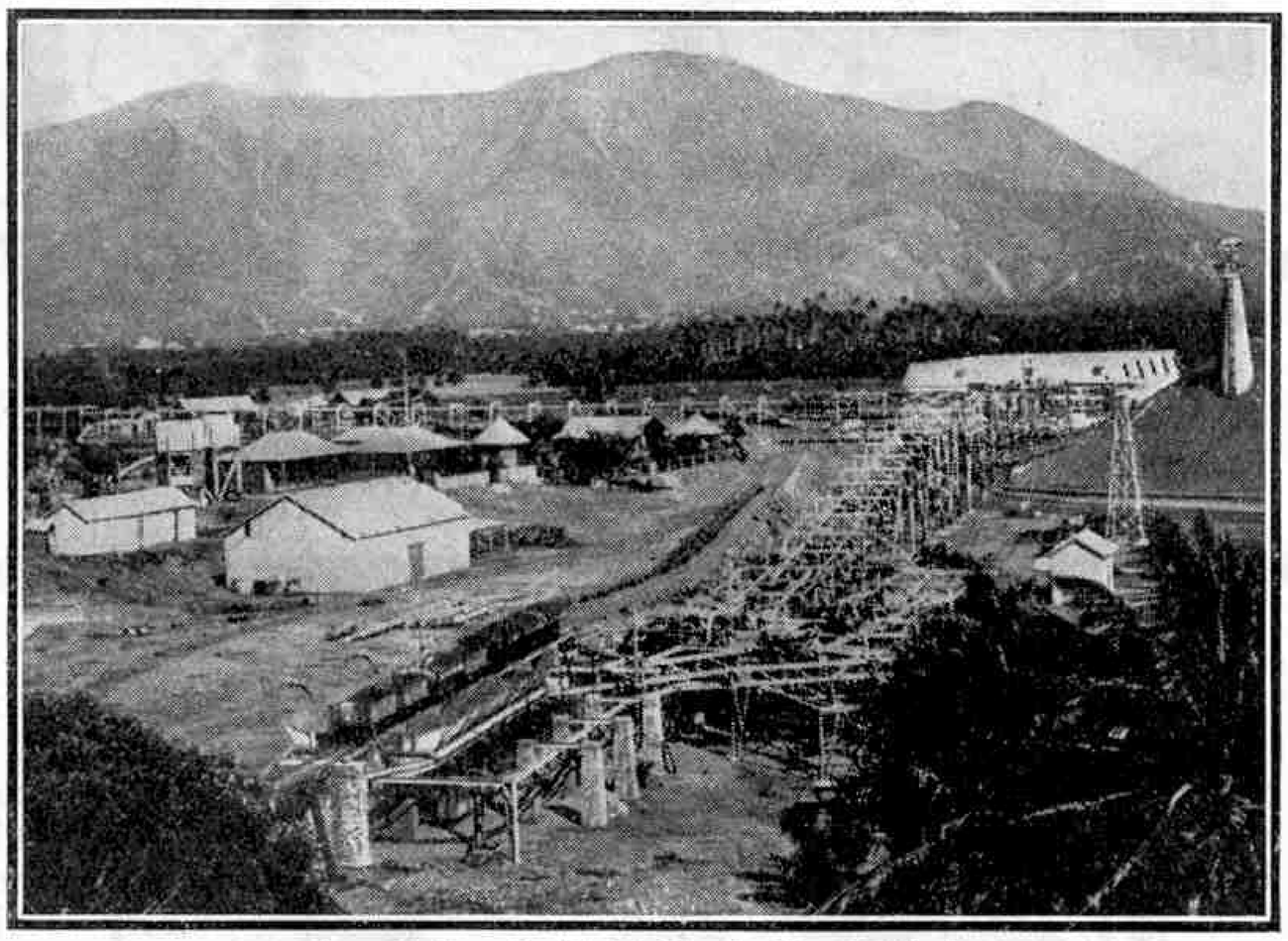
The experience of the Saxon miners was subsequently shared by miners in Ontario. Copper deposits were discovered there in 1856, but it was not until the Canadian Pacific Railway was being pushed westward from Sudbury nearly 30 years later that they were given serious attention. In 1883, when the vast forests of this province were penetrated during the construction of the line, copper deposits of great richness were discovered. Great excitement prevailed and mining operations on an extensive scale were quickly commenced. The ore was despatched to the United States to be smelted, but it was found that nothing would induce the copper to separate from the ore. The trouble was traced to the presence of nickel, and entirely new methods of treatment had to be evolved to bring about the separation of the nickel and the copper. Once the smelting difficulty was overcome the output of nickel from Canadian ore rapidly increased, and by 1923 more than 90 per cent. of the world's production of the metal was derived from Canada, the remainder being obtained mainly from New Caledonia.

One of the most important of the Sudbury mines in Canada is the Frood Mine, a mile or two outside the town, and shown in one of the accompanying illustrations. This well-known mine is sunk to a depth of 3,100 ft. along an ore bed that has already been proved to contain over 135,000,000 tons. The first working level is 1,600 ft. underground, and successive levels branch off from the main shaft every 200 ft. down. The cavities or "stopes" where the ore is actually mined are reached by way of narrow branch passages known as "side drifts," which lead off from the main levels. The stopes are floored with thick wooden planks, and massive timbers support the rocky ceiling 7 ft. overhead.

The rock unavoidably broken down along with the ore is sorted out by the miners, who pack it in behind as the cut into the ore bed advances; and the ore is dropped down chutes into bins that discharge it into 10-ton wagons. The loaded wagons are collected by small battery-driven locomotives and made up into trains that are hauled to the main dump on that particular level. The necessity of this efficient and rapid transport underground is shown by the fact that on the 2,800 ft. level the main shaft is 2,200 ft. away from the ore bed, owing to the latter extending downward into the earth at an angle of 65 degrees. At the dump a wagon unloader tips the ore into a crushing plant that reduces the large lumps and passes the ore through a screen into six-ton skips. These containers travel at a speed of 3,000 ft. per min. and rush the ore up to the rock house at the surface, where it is subjected to further sorting and crushing, and finally is loaded into wagons for transport to the smelting plant at Copper Cliff, a few miles away.

At Copper Cliff the ore is passed through successive crushers that reduce it to the equivalent of fine sand. The powdered ore is

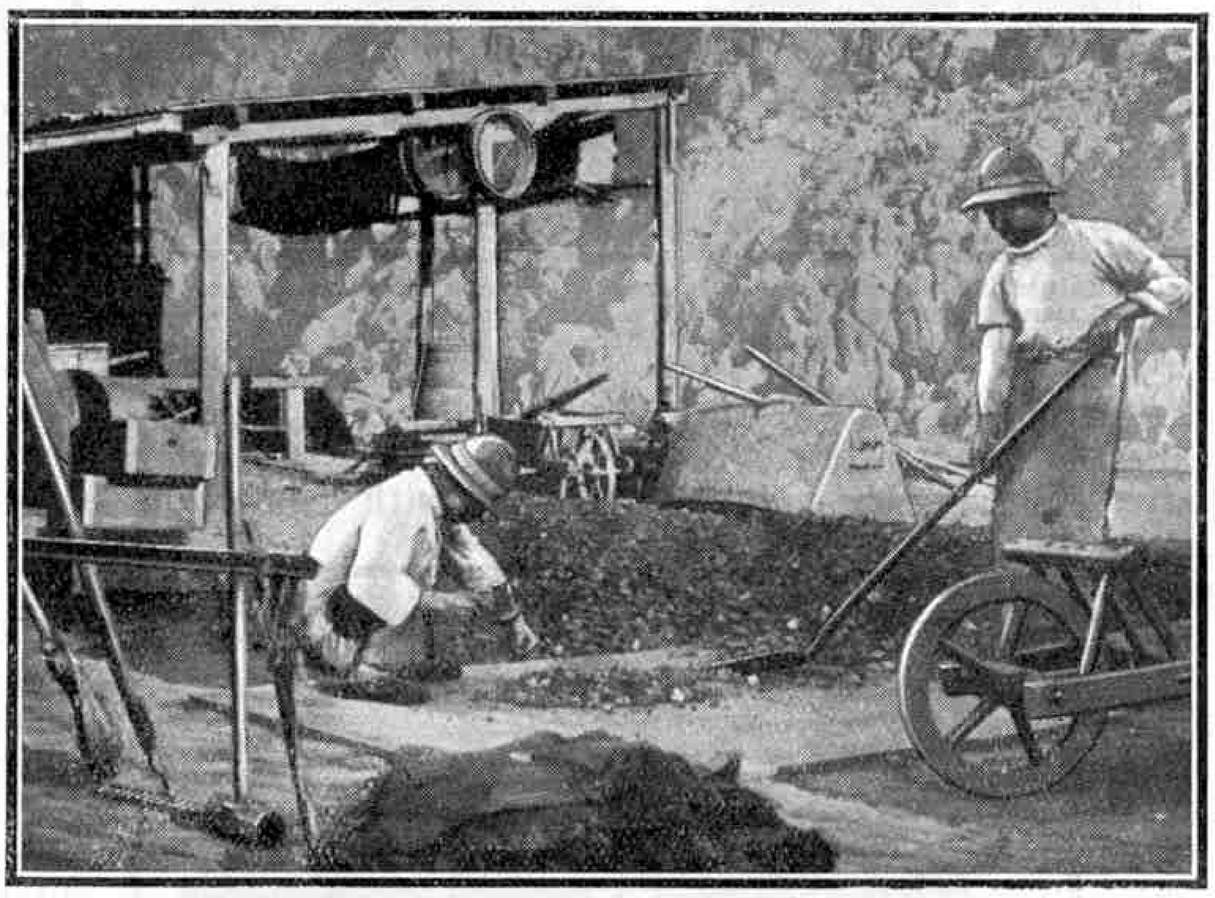
then converted into a kind of thick slime by the addition of water, and subsequent treatment in large "flotation" tanks effects a rough separation of the nickel and copper sulphides. The nickel sulphide is drawn off from the tanks, de-watered in a special plant, and carried by a mechanical conveyor out of the mill and up to the top of the smelter, 160 ft. high, where conveyors distribute it to the tops of huge roasting furnaces. In these furnaces the ore is made to gravitate downward through 11 successive hearths until it finally drops into a reverberatory furnace, in a condition just below melting point, and with some of its sulphur content eliminated. The attack on the sulphur is continued in the reverberatory furnace and afterwards in a converter, similar to that used in the manufacture of steel, where most of the iron content is also removed. The molten ore, or "matte" as it is called, is then poured into moulds, and when solid it is ready for refining.



General view of a Nickel Mine in New Caledonia.

The final stages of the production of pure nickel are carried out in various ways, the particular method used depending largely upon the composition of the matte produced in the smelting process. The matte from the Sudbury mines is refined either in Canada by the Orford process, or exported to Swansea, South Wales, where it is refined by the Mond process.

The Orford process of copper and nickel separation depends upon the chemical action of sodium sulphate on the matte in the presence of carbon. The sodium sulphate is converted into sodium sulphide, and this dissolves out the copper compounds, leaving the nickel unaffected. The molten matte is then drawn off into great pots, and the nickel sulphide, being the heavier, settles to the bottom. The pots are inverted when their contents have solidified, and an examination of the matte shows that the copper "tops" have broken away from the nickel "bottoms." There is a certain amount of nickel sulphide in the copper tops, however, and some copper with the nickel in the bottoms. The tops therefore go to a converter, where the sulphur is eliminated and the nickel content drawn off. The nickel bottoms are taken to a blast furnace where they are smelted with coke and sodium sulphate. This treatment removes the remaining copper, forming further copper tops, and the purer nickel bottoms, or final matte, that is shipped to the nickel refinery at Port Colborne, on the Welland Canal.



Testing a sample of the ore brought up at a Nickel Mine.

At the refinery the matte is crushed by hard steel balls in rotating drums, screened through $\frac{1}{8}$ in. mesh, and treated with water to remove the sodium sulphide. It is then roasted in furnaces of special construction, in which most of the remaining sulphur is burned out, leaving nickel oxide. This is mixed with soft coal containing a high percentage of carbon, and melted in oil-fired reverberatory furnaces. The process yields a metal containing 96 per cent. pure nickel, which is poured into moulds where it solidifies in plates weighing 450 lb. each.

The plates are then taken to huge electrolytic tanks containing a solution of nickel compound. The plates are suspended in the solution to form the positive pole or anode, and when electric current is switched on pure nickel is deposited on plates forming the negative poles or cathodes, the process being similar to electroplating. Plates of 99.73 per cent. pure nickel are formed on the cathodes in this manner. The process goes on day and night, each cathode building up at the rate of about 8 lb. every 24 hours. When the cathode reaches a weight of 125 lb. it is removed and cut up into convenient sizes as required by buyers.

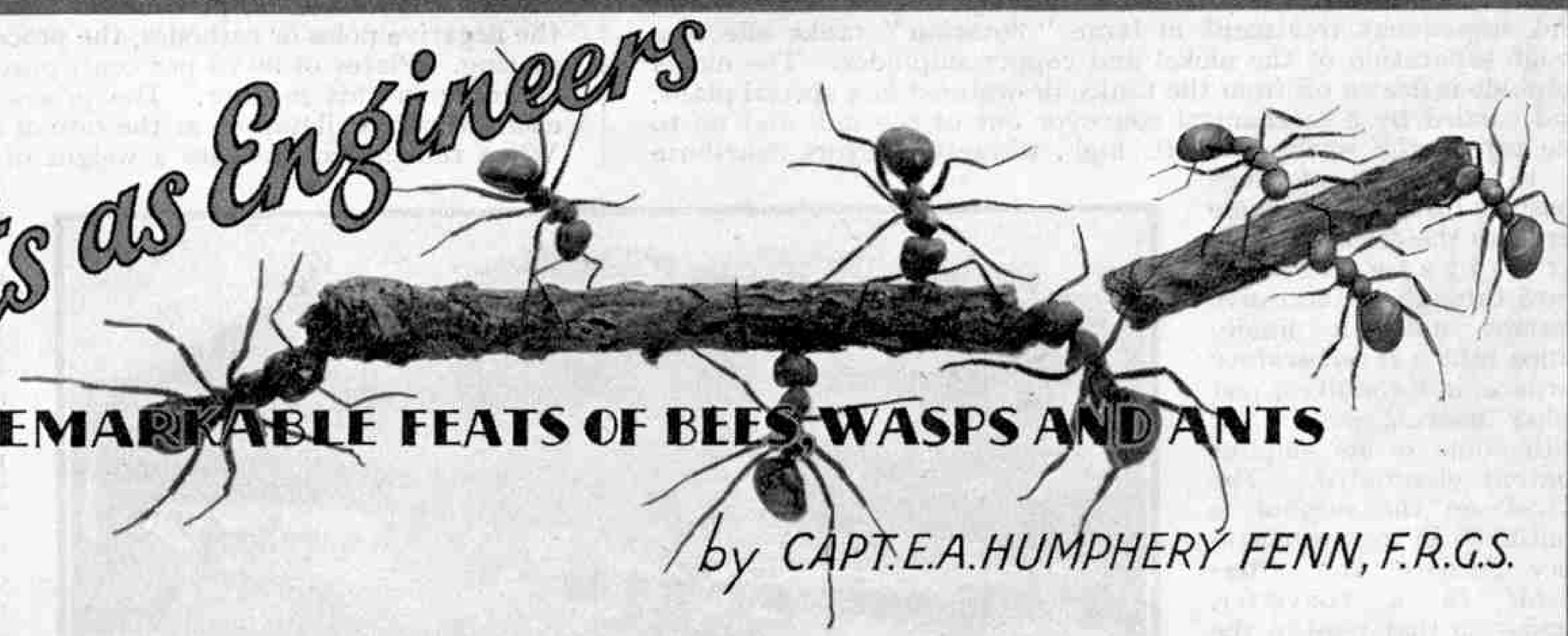
The Mond process in use at Swansea was the invention of Dr. Ludwig Mond. The matte obtained from Canada is first crushed and then roasted in furnaces, through which it passes continuously in conveyors from the crushers. The resulting mixture of copper oxide and nickel oxide is treated with dilute sulphuric acid, which dissolves out the copper oxide, but leaves the nickel oxide behind. In order to reduce this oxide the Mond process employs hydrogen. This gas is not used in the costly pure form, but instead water gas obtained by blowing steam over red-hot anthracite is used, as more than half of this is hydrogen. The gas enters at the bottom of an iron tower while the nickel oxide is fed in at the top. Inside the tower are shelves with openings in them, and scrapers are arranged to spread out the oxide and make it travel from one shelf to the other downward, so that the oxide and the gas travel in opposite directions. The temperature is raised to about 350°C. and the hydrogen reduces the oxide to the metal.

Now comes the most striking feature of the Mond process. We all know of the gas called carbon monoxide. This gas is present in small proportions in ordinary coal gas, to which it gives poisonous properties, and it is also formed in both coal and coke fires, in which it burns with a bright blue flame. Mond found accidently that when nickel is gently heated in this gas it forms a new gas now called nickel carbonyl, and that the nickel is easily regained by heating more strongly.

The first part of this process is carried out in a tower similar to the one used for reducing the oxide. Pure carbon monoxide enters at the bottom of the tower, in which a temperature of 80°C. is maintained, while the impure nickel passes from the top downward to meet the stream of ascending gas, thus forming the gaseous nickel carbonyl, which passes on to the decomposer. This is a long cylinder built in sections. The gas enters by a pipe passing down the centre of the cylinder and distributing the gas in the sections, where the temperature is kept at about 180°C., which is high enough to cause the gas to break up, the nickel being deposited in a thin film on pellets of nickel already present from previous operations. The pellets are worked slowly down by mechanical means and discharged in small quantities at a time into a small lift that carries them to the top of the decomposer again for a repetition of the process.

In this manner the pellets grow slowly larger and larger until they are suitable for the market. The continuous motion gives a spherical shape, and any pieces broken off provide a commencement for the formation of new pellets. The growth of these pellets is one of the marvels of industrial chemistry. If a pellet is cut in two, the layers of nickel formed during (*Continued on page 500*)

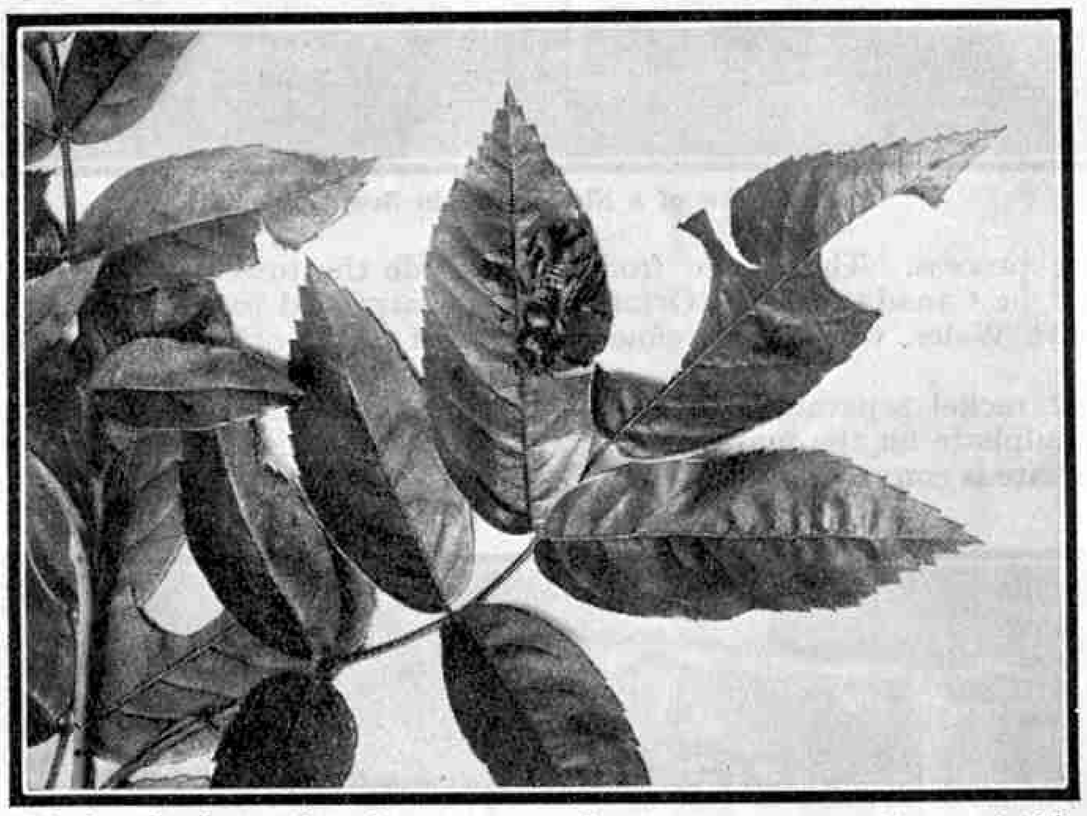
Insects as Engineers



REMARKABLE FEATS OF BEES, WASPS AND ANTS

by CAPT. E. A. HUMPHERY FENN, F.R.G.S.

INSECTS constitute a very considerable and interesting part of the animal kingdom. Their variety is enormous; ants alone total over 2,000 species, and there are 1,500 recognised species of bees. It is not surprising therefore that abundant proof of the industry of insects is found everywhere. It is interesting to reflect that their industries were at work long before the coming of Man, and from insects Man must have learned many lessons of engineering and architecture. Thus the silken web that the spider weaves adorned the primæval forests as it adorns the countryside to-day, and there was a government in the world of bees long ages before there was a government in the world of Man.

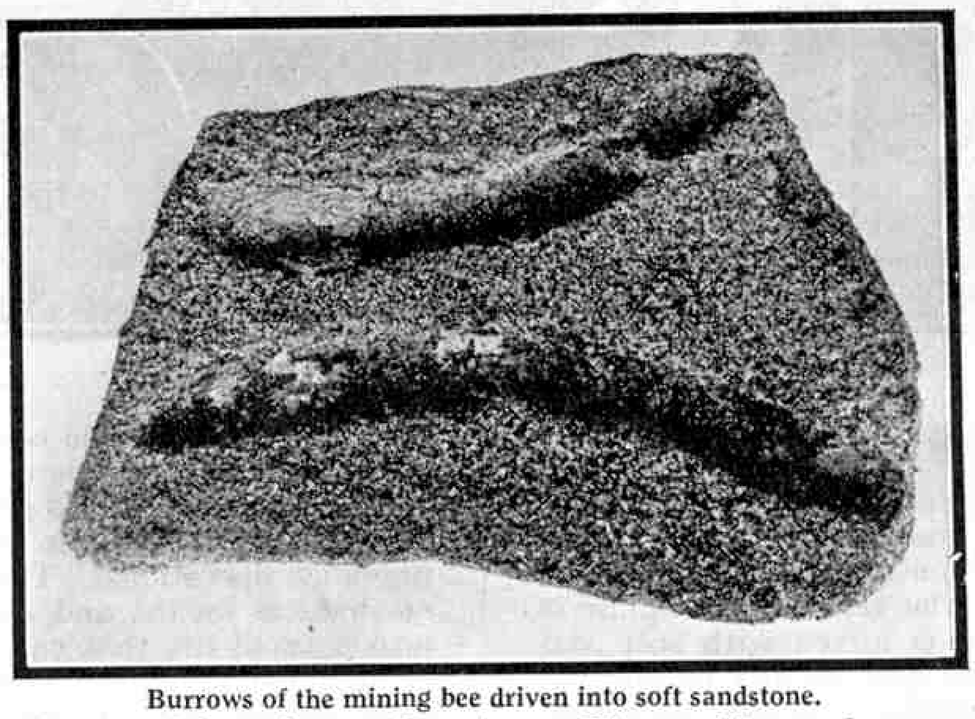


A leaf-cutting bee cutting a lozenge-shaped piece from a rose leaf. Pieces cut off in this manner are used to form the cells of the bee and these are capped with circular pieces of leaf after being filled with food. The illustrations to this article are from photographs by H. Bastin.

Linnaeus, the great naturalist, once said that "Nature is most marvellous in the smallest of her creatures," and it is easy to agree with him after observing the industry and skill displayed by bees, wasps and ants. Bees may be grouped into two classes, the social worker or hive bees, and the solitary bees, but the chief industry of both classes is the formation of structures for the protection of their eggs. The construction of the cells by the social worker bees is hardly more wonderful than the work of the many species of solitary bees and wasps found in this country. The organisation of a hive is that of a well ordered factory. The division of labour is fair and adequate. The co-ordination of effort to attain a single object is made perfect by each tiny worker striving at its own particular task, never impeding one another by interference.

The honeycomb built by the hive bee is a large group of hexagonal cells made of thin sheets of beeswax and is a perfect structure for its particular purpose. The wax is produced in the form of tiny and almost white scales by six wax-secreting organs, three on each side of, and just under, the bee's abdomen. The bee transfers each wax scale to its mouth, a modified joint in one of its hind legs enabling it to accomplish this. The scale is then masticated by the insect's strong jaws until, with the aid of saliva, it is converted into paste, and in this pliable form it is used in building the familiar honeycomb.

The bee first attaches a piece of wax to the roof of the hive and then hollows out small depressions on each side of the wax, these depressions forming the bases of the first cells. Other bees then assist in the work, more wax is added and cell bases are formed, and ultimately a thin vertical sheet of wax, covered on both sides with regular depressions, hangs like a curtain from the roof of the hive. While this work is going on other bees build up the sides of the cells, and so perfectly are the cells made to fit one against the other that no waste spaces occur between them. The cell bases on each side of the comb engage alternately, and the pyramidal depression that is the base of a cell on one side of the comb serves to cover part of three cell bases on the other side. By this ingenious arrangement the maximum number of cells are built in the comb with a minimum quantity of wax.

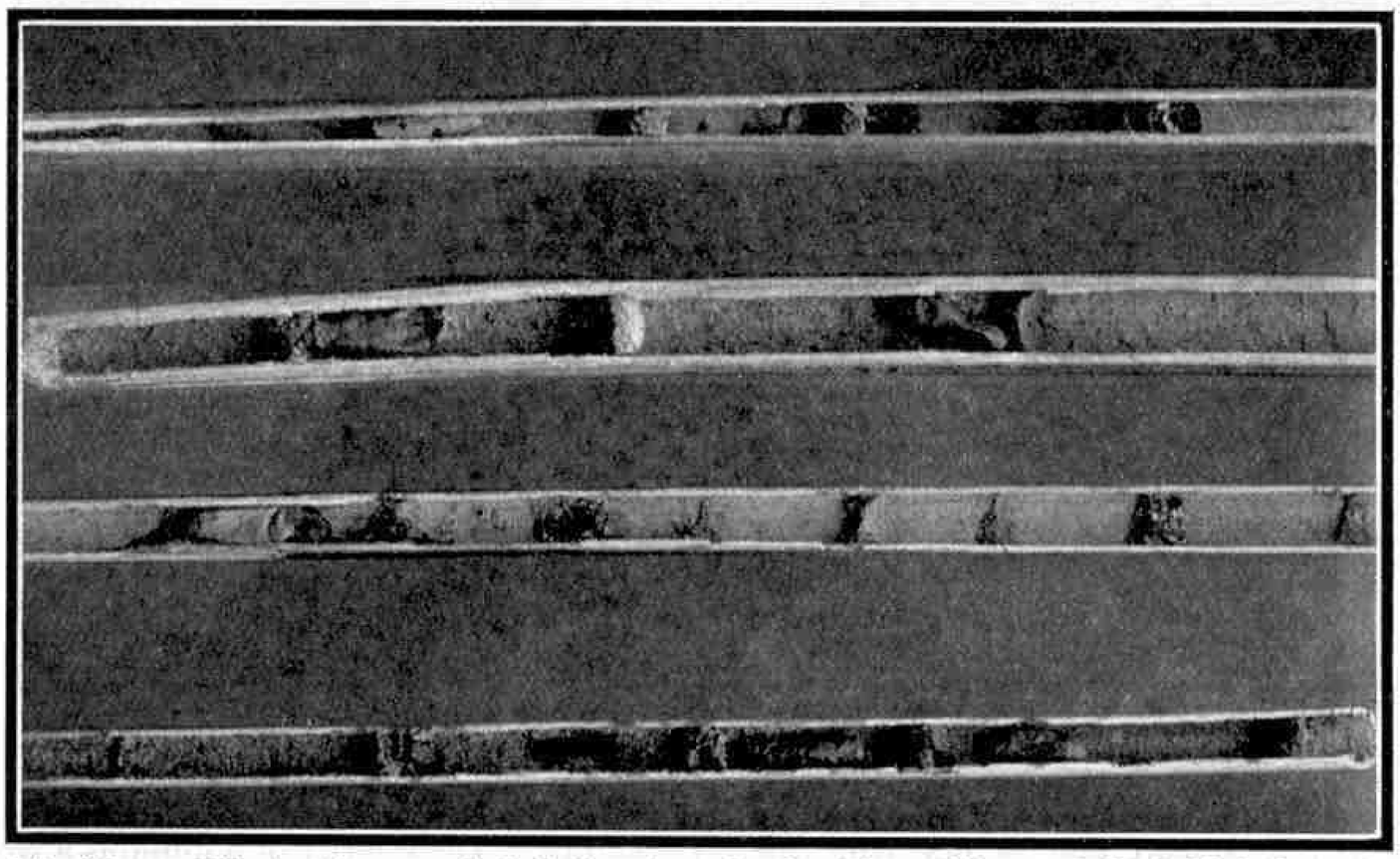


Burrows of the mining bee driven into soft sandstone.

The solitary bees are the mason, carpenter, mining and upholsterer bees. Some idea of the art and ingenuity of the work of the solitary bees may be obtained from the following observation of a certain mason bee. This bee was found on a wall, excavating a hole in one of the

bricks about five feet from the ground. There may or may not have been a hole in the brick before the insect began her labours, but the brick was of a hard kind. Great care was taken to remove the particles of brick dust, detached by means of the strong, tranchant-toothed jaws, from the scene of operation, as these, dropping to the foot of the wall, would have led to the discovery of her nest by one of her numerous enemies. The material was carried in her jaws as she retreated backwards.

When clear of the hole that she is excavating, a mason bee descends to the ground and there mixes the particles of brick dust with earth, using her saliva to work up the mixture into a kind of cement. When this process is completed the industrious bee grasps a particle of the material and flies back to the wall, to which, at a selected spot, she fastens the particle. These operations are repeated until the cell is completed. At first sight it looks like a small lump of mud that has been thrown against the wall and has stuck to it. The bee then flies away and gathers honey and pollen and, returning to the cell, disgorges this food supply and mixes the honey and pollen into a sweet paste. When the cell is half filled with this substance the bee deposits an egg on it and then seals up the cell by covering the entrance with a layer of fine undiluted mortar. This business of building a home, furnishing it with a food supply, laying an egg and sealing up the home takes the bee from two to four days to complete. She then starts work on another cell, close to the first, and repeats her labours until eight or ten cells have been built, furnished and sealed.



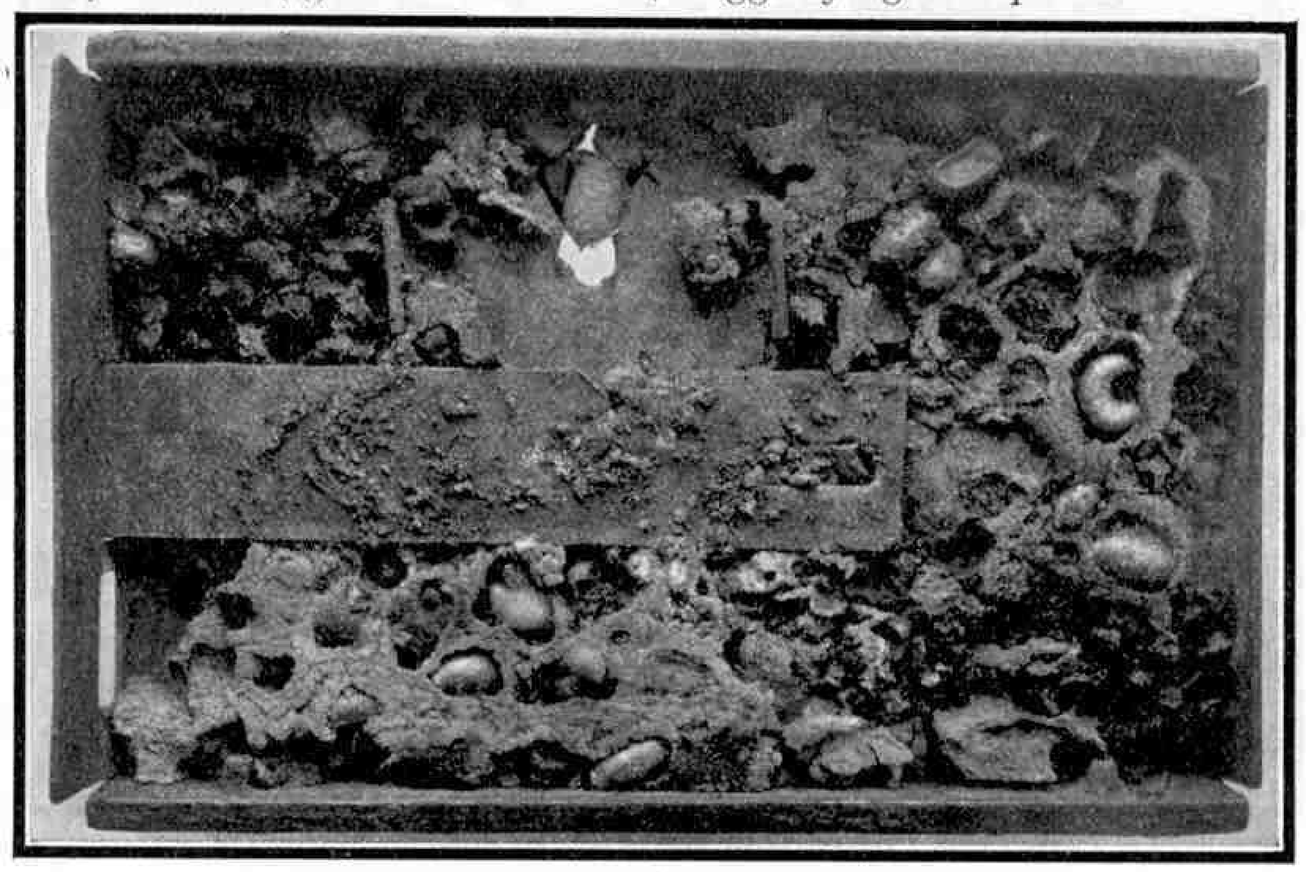
Cells of the small black solitary wasp in the hollow stems of reeds. The partitions are built of a kind of concrete formed from sand and the insect's saliva.

Another species of mason bee builds her nest in a bank of hard sand. Although hard sand may be more difficult to penetrate than soft, it is less liable to fall down, and however hard the sand the insect bores a tubular gallery two or three inches deep. Moisture from the bee's mouth renders the material more pliable. With the detached grains of moistened sand the bee kneads pellets and with these she forms a small round tower, which, as in the structural work of all bees, is curved like the creature's body. This tower is to protect the young from the sun, and from enemies.

Mason bees are rare in this country, but in Egypt, where they are very common, hundreds of mason bee nests can often be seen clustered together on ancient monuments and temple ruins. The bees concerned use mud from the banks of the Nile for building their nests. Mason bees are also very common in some parts of France.

Carpenter bees work in wood as the mason bees work in stone or brick, choosing generally the woodwork of buildings beginning to become soft with rot, or the decayed wood of posts or palings. Some bore a hole in the pith of dead twigs of bramble and other bushes. The carpenter bee, working in solid wood, bores a tunnel just large enough to travel along comfortably, chipping away the wood with her strong jaws. The tunnel is bored horizontal for a short distance and is then diverted downward. When it is completed the bee clears it of dust, then gathers nectar and pollen from flowers, and at the base of her tunnel-shaped nest makes this material into a ball, on the top of which she lays an egg.

The methodical insect then collects some of the tiny chips of wood she had cut away, lays them over the egg-carrying pollen, and binds them together with saliva so that they form a partition that serves as the floor of the next cell. The business of pollen gathering, ball making, egg laying and partition building is then repeated until several cells have been constructed and furnished. Some carpenter bees line their nests and form the partitions between them of thin clay, but all are elaborate in their home-planning. When the eggs hatch, the young bees feed on the pollen balls until fully grown, and then break their way through the thin partition and gain the open air.

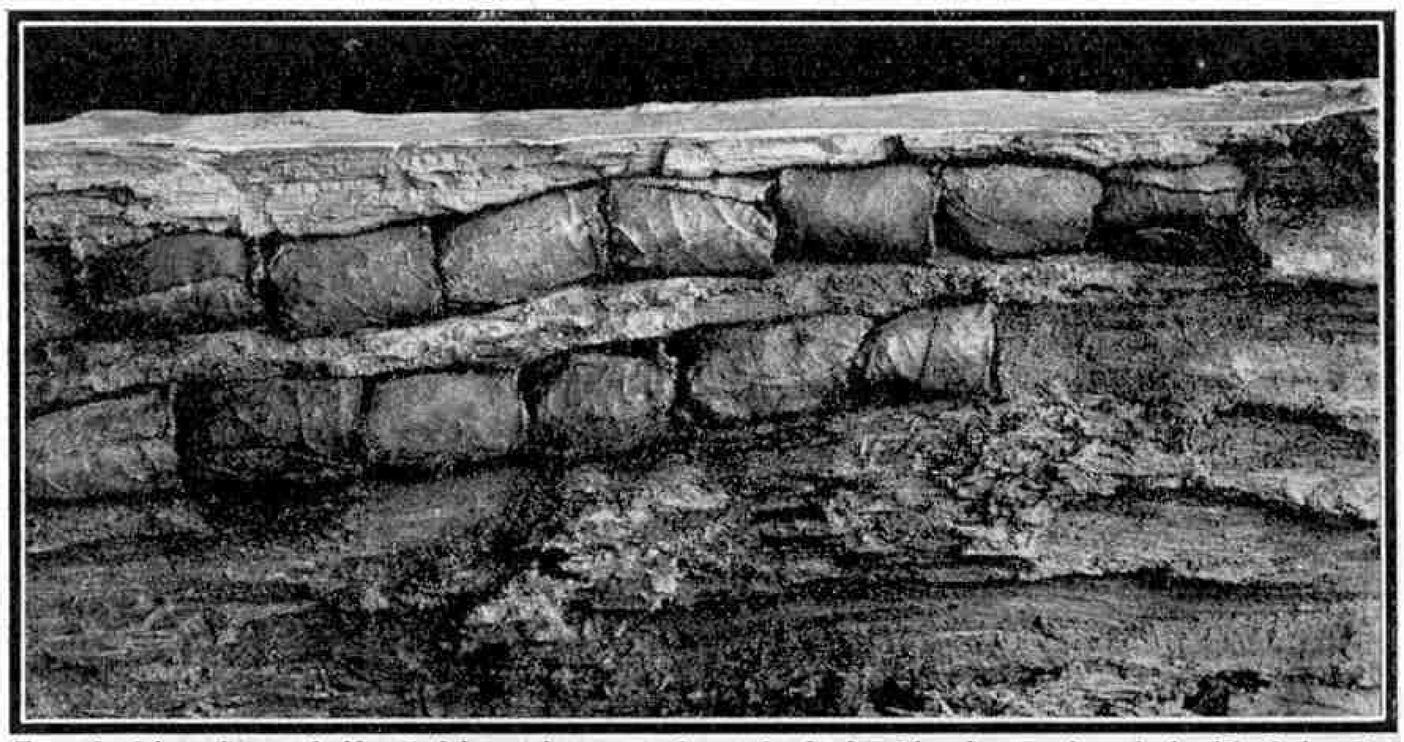


The lock of an outhouse almost filled with cells of the British mason bee.

Mining bees are small, often hardly larger than the familiar house fly, and they dig in the ground instead of in stone or wood, excavating tubular galleries little wider than their own bodies. These industrious miners then bore tiny holes off the main passage to receive their eggs. The walls of these hollows, or cells, are then glazed, and resemble the interior of an earthen jug. Pollen and nectar are gathered and mixed in the usual way, and a supply is placed in each cell. The bee then lays an egg in each compartment and seals this, the cell remaining closed until the egg hatches and the young insect matures and breaks through. Unlike the hive bees, the female miner bees each make their own nests, but hundreds of these

nests may be very close together. The male bees are conspicuous by their idleness.

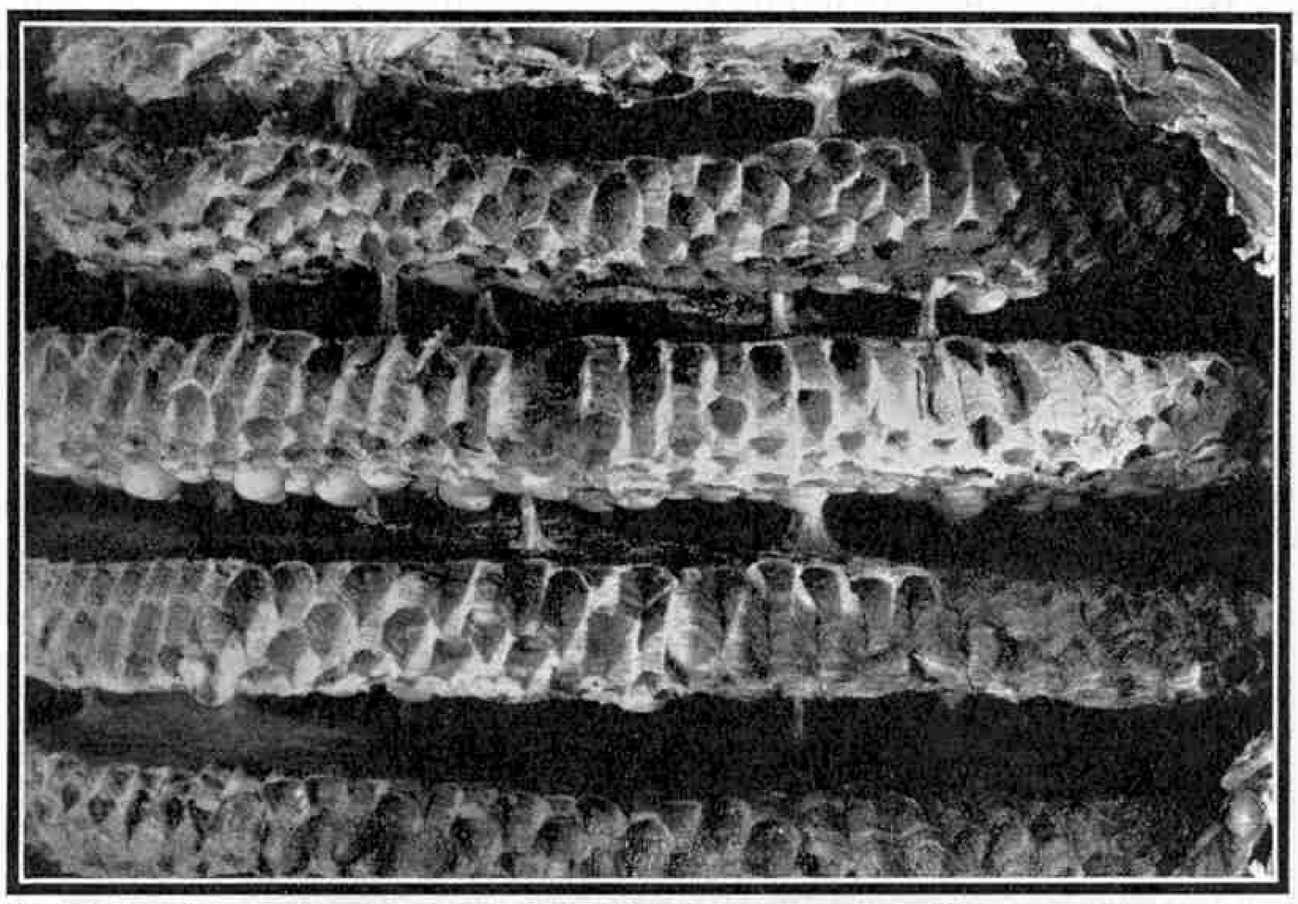
Upholsterer bees do not go to the trouble of boring a tunnel to serve as a nest, but content themselves with small ready-made apertures such as the crevices between shingles. These bees are also known as leaf-cutting bees on account of their habit of lining their nests with leaves. They do not confine their attention to leaves, however, and often they use the petal of the common scarlet poppy. Taking a petal, the female upholsterer bee cuts off small oval-shaped pieces, seizes them between her legs, and conveys them to the nest. Two or three thicknesses of poppy petal are used. It will be found difficult to cut a poppy petal into sections with scissors, but the bee appears to perform the task with ease. When the whole of the nest has been upholstered in scarlet, the floor is covered with pollen mixed with honey. After the eggs have been laid they are covered with poppy petal, and the upper part is filled in with earth for protection. It is not known why the poppy should find favour with the upholsterer bee. Perhaps it is on account of its flexibility and softness; or it may be mere desire of brightness in the home.



Tunnels driven into a half-rotted beam in a greenhouse by leaf-cutting bees and packed with their cells.

The upholsterer bees that use the petals of poppies are known as poppy bees; other upholsterer bees that use the leaves of the rose are known as rose cutter bees; and still others prefer the petals of pansies.

Wasps, like bees, may be divided into two general groups, social wasps and solitary wasps. The social wasps live very much like the social bees, and include queens, workers and drones; and similarly their chief concern is the construction of a nest to receive and protect their eggs. They construct their nests in different ways, some of them suspending it from the branch of a tree and others from the rafters of an old barn; while some prefer a hole dug in the ground. In each case the nest is made of leaves or wood fibre that has been masticated into a pulp by the insect. The nests of some of the social wasps in tropical countries are huge affairs, and one species in Ceylon builds a suspended nest six feet long. A South American species of social wasp mixes earth with paper pulp and with this compound builds walls that set as hard as stone.



The interior of a wasp's nest. The successive tiers of cells are suspended by means of stout columns.

Social wasps are very active insects, but they are not as intelligent and skilful as solitary wasps, of which there are many hundreds of species, including mason, carpenter and caterpillar wasps. Mason wasps generally construct their nests of mortar and small stones, adhered to walls or rocks. Carpenter wasps bore holes in trees or wooden posts, or extract the pith from the stems of certain bushes, to make room for their group of cells.

The caterpillar wasp builds her nest in the ground, generally screened from view under a leaf of some plant. The nest is really a tunnel a few inches long that leads steeply down to a small chamber. When the wasp is about to go on a hunting expedition she skilfully closes the opening of her nest with a lump of earth of suitable size, and smooths it over so skilfully that it is difficult for even an expert naturalist to discover her abode. She then goes in search of a caterpillar, and having rendered this helpless she conveys it to the nest and deposits it in the underground chamber. After laying an egg on the caterpillar she commences to seal up the chamber. Emerging from the nest, she breaks away some of the earth from the sides of the tunnel and jams it down with her head, afterward dislodging more earth and repeating the process until the hole is filled up to ground level. She then grasps a small pebble in her jaws and with it hammers down the earth over the nest, pausing every now and then to lay aside the pebble and add more earth. When the task is completed to her satisfaction she flies away to begin the work over again at some fresh site.

All the species of ants are collective or social; there are no solitary species as in the case of bees and wasps. Ants are skilful and elaborate in their work, and their industry is proverbial. Solomon said "Go to the ant, thou sluggard; consider her ways and be wise! Which, having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvest." One cannot watch a colony of ants for long without being filled with admiration for their alert movements and ceaseless energy.

The mason ants live in the ground, in conical hillocks known as humps. The interior of a hump is a wonderful network of tunnels and must have provided many a human engineer with a plan. It is serrated by large passages, oval in form, and the nests are in tiers one above the other, with partitions. Some of the tiers of the nests are above ground and some beneath, but all follow the slope of the ant hill.

The carpenter ants, which work in wood, perform much more extensive operations than do the carpenter bees. Their only tools are their jaws, and although these are not as elaborately constructed as those of some other insects, they are quite efficient. The most common carpenter ant is the emmet or jet-ant. It is not as common in Britain as the mason ant, but can sometimes be found in the trunk of a decaying oak or willow tree. The carpenter ant always works in the interior of the tree, and therefore its operations are screened from view. The galleries it makes are horizontal, hidden mostly by the walls, which follow the direction of the layers of the wood. Sometimes, when the works are constructed in the roots of a tree, this plan is not adhered to, owing to hardness or to the deviation in the general direction of the wood. The work of the carpenter ants in wood has the appearance of elaborate and skilled carving, and nothing that human skill could devise could attain such a result, as the operations are extremely minute and intricate. For a reason unknown the structural works of the jet-ant are all tinged with black, as if smoked. It may be caused by formic acid, but it is not found in the works of other ants.

Caterpillars also are clever builders. The tent-making caterpillar belongs to a family of small moths, and feeds on the leaves of common trees, such as the elm and the oak, and on most fruit trees. It builds a small tent-like structure about a quarter of an inch long on the leaf, the material for the tent being eaten out of the leaf itself.

The stone mason caterpillar feeds on lichens growing on walls, and builds for itself a portable tent. To construct its home, this caterpillar detaches tiny particles of stone, binding each with silk into the wall of the structure, until the cell has attained the required size. When they prepare to change into chrysalides, before becoming moths, they attach these "tents" to the stone over which they have hitherto rambled, by spinning a strong mooring-line of silk between the entrance to the tent and the *(Continued on page 500)*

The Jumping Bean of Mexico

A Caterpillar's Gymnastic Feats

ONE of the most remarkable of the world's curiosities is that known as the Mexican jumping bean. Although clearly a vegetable product, it rolls over and even jumps into the air as if it were alive. It retains its strange power for more than six months after ripening, and appears to be more active when heated or exposed to the Sun.

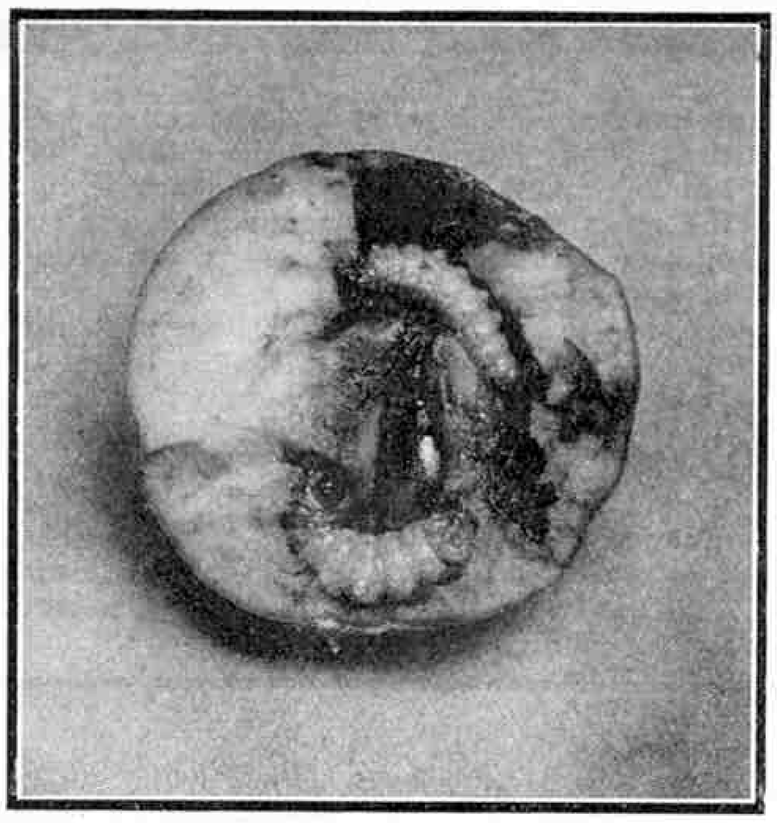
The jumping bean is not really a bean at all, but is the bean-shaped fruit of a plant that grows in the province of Sonora in Mexico. This plant is known to the natives as "hierba del flecha," or "herb of the arrow." Some of the fruits obtained from it do not jump, and the secret of the extraordinary behaviour of those possessing this peculiarity is that they contain a caterpillar developed from the egg of a moth that has been deposited in the flower of the bush. On hatching out, the caterpillar bores its way into the growing bean, where it feeds on the tissues, leaving the hard skin untouched. It is ready for the change into the pupa or chrysalis stage when the ripe fruit falls to the ground, but this change does not occur until several months later, and in the meantime the fruit shows the curious behaviour that has given it the name of jumping bean.

The fruit of the "herb of the arrow" is an ideal place for the development of the caterpillar, for the plant grows in marshy areas in a climate of suitable temperature. The bean falls in the dry season, and then there is danger of scorching from the rays of the Sun. This would cause the death of the inmate, and in order to avoid such a fate the caterpillar makes the bean roll over with a peculiar jerky motion until a shady place is reached. It appears to be in complete control of the curious vehicle in which it lives and travels, and is even able to change the direction of movement if a few rolls do not bring the desired relief from the overpowering heat.

The caterpillar inside a jumping bean moves its home in a remarkable manner. A boy imprisoned within a wooden box would be unable to move it by merely pushing it on one side, for the reaction due to the thrust of his feet would be equal to the force he applied and would act in the opposite direction. He could make progress by throwing himself against the top of one side of the box, however, for then he would be able to roll it over and, by using his weight against the proper side, move his prison slowly and clumsily in any direction he pleased. The caterpillar inside the jumping bean acts in a similar manner. It spins a silk lining for its strange home, and whenever the need for changing quarters becomes apparent it seizes this lining firmly with its tail, and with its head strikes the wall of the bean immediately above the point to which it has attached itself. Repeated blows give the bean sufficient impetus to cause spasmodic movement, or even to make it roll over. When the caterpillar wishes to change the direction in which the bean moves, it simply seizes another section of the lining with its tail, and aims its blows at a different portion of the wall.

The caterpillar is not jerked over helplessly when the bean moves, nor is it thrown violently about inside its home, for nature has provided it with a brake by means of which it prevents the bean from rolling over too quickly. Every time it strikes its head against the inner wall of the bean a sticky thread is attached to the point at which it knocks, and it reduces the speed of the rolling movement by pulling backward on the threads.

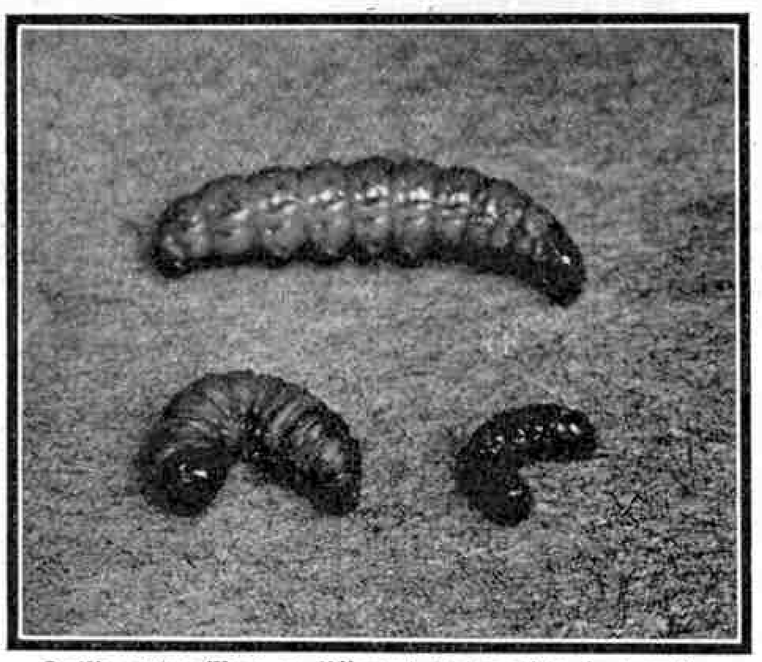
The caterpillar must be quite comfortable in its strange dwelling place, for if a hole is made in the hard skin of the bean it makes no attempt to escape, but immediately weaves a silken web over the opening. Even if it is forcibly removed, it crawls back if given an opportunity of doing so and in a few hours again seals itself into its home. One of these creatures was persuaded to weave its web round a tiny piece of thin glass covering a hole cut in the shell of the bean in which it lived, and its strange method of causing its home to jump and roll was then revealed.



Caterpillars of the codlin moth in the core of an apple.

Except when high temperatures disturb it, the caterpillar remains quietly in the bean until early in the following year, when it cuts a ring in the shell. The perfectly circular plate marked out in this manner is not removed until the moth emerges from the chrysalis into which the caterpillar is transformed. Then a gentle push is sufficient to cause it to fall away and the moth creeps out, to spread its wings and reveal itself as a tiny creature, two-thirds of an inch across, that is prettily marked with dark and reddish brown bands.

The moth that emerges from the jumping bean is a relation of the codlin moth, a well-known British insect that derives its name from the partiality of its caterpillar for the seeds of the codlin apple. Unfortunately this tiny creature does not confine its ravages to one variety of apple, and it is even found in pears. It is grey in colour, with a black polished head that becomes brown as it gets older, and it is only three-quarters of an inch long. It is hatched out from flattish oval eggs about the size of a pin head, laid on the young apples in May, and it then bores its way to the core, evidently in search of the seeds. There it remains until it has devoured as much as it wishes, and then tunnels its way outward, its tracks through the apple being marked by darkening and decay.



Codlin caterpillars at different stages of their growth.

Sometimes the attack of the caterpillar causes the apple to fall to the ground, and the creature then conceals itself under twigs or leaves. If the fruit is still on the tree when it emerges, it makes its way to the ground along the branches, or lowers itself by means of a silken thread. Many of the caterpillars remain in crevices in the bark for the winter, but wherever they hide themselves, in due time they pass into the pupa stage and ultimately develop into codlin moths. These are slightly larger than their relatives from Mexico, for from the tip of one wing to that of the other is about three-quarters of an inch.

From the stems of the plant on which the jumping bean grows the Indian natives of Sonora formerly obtained a poisonous juice into which they dipped the heads of their arrows. The beans ripen between June and August, and gathering them from the ground on which they fall when mature is a dangerous occupation, for snakes, scorpions, tarantulas and other poisonous creatures often lurk under the bushes.

Although no British insects help to produce jumping seeds, in other respects the activities of many of them resemble those of the Mexican moth. For instance, there is a small moth, known as the pea moth, that lays its eggs in the flowers of the garden pea, one or two being placed in each blossom. The pods are fully formed by the time these eggs are hatched and the grubs remain inside, feeding on the peas. It is of course easier for them to leave the pods than for the caterpillars of the Mexican insect to cut their way out of the beans of the "herb of the arrow," and they bury themselves in the soil in order to pass the winter.

Day Trips to Switzerland !

This summer the continental services of Imperial Airways have been specially augmented to provide many fresh facilities for holiday passengers. On the London-Paris route, for instance, five services are flown in each direction every day, the first departure for Paris being from the London air port at 8.0 a.m. and the last at 6.30 p.m. It is possible to fly over to the French capital in the morning, spend nine hours there, and return to Croydon by 9.30 the same night.

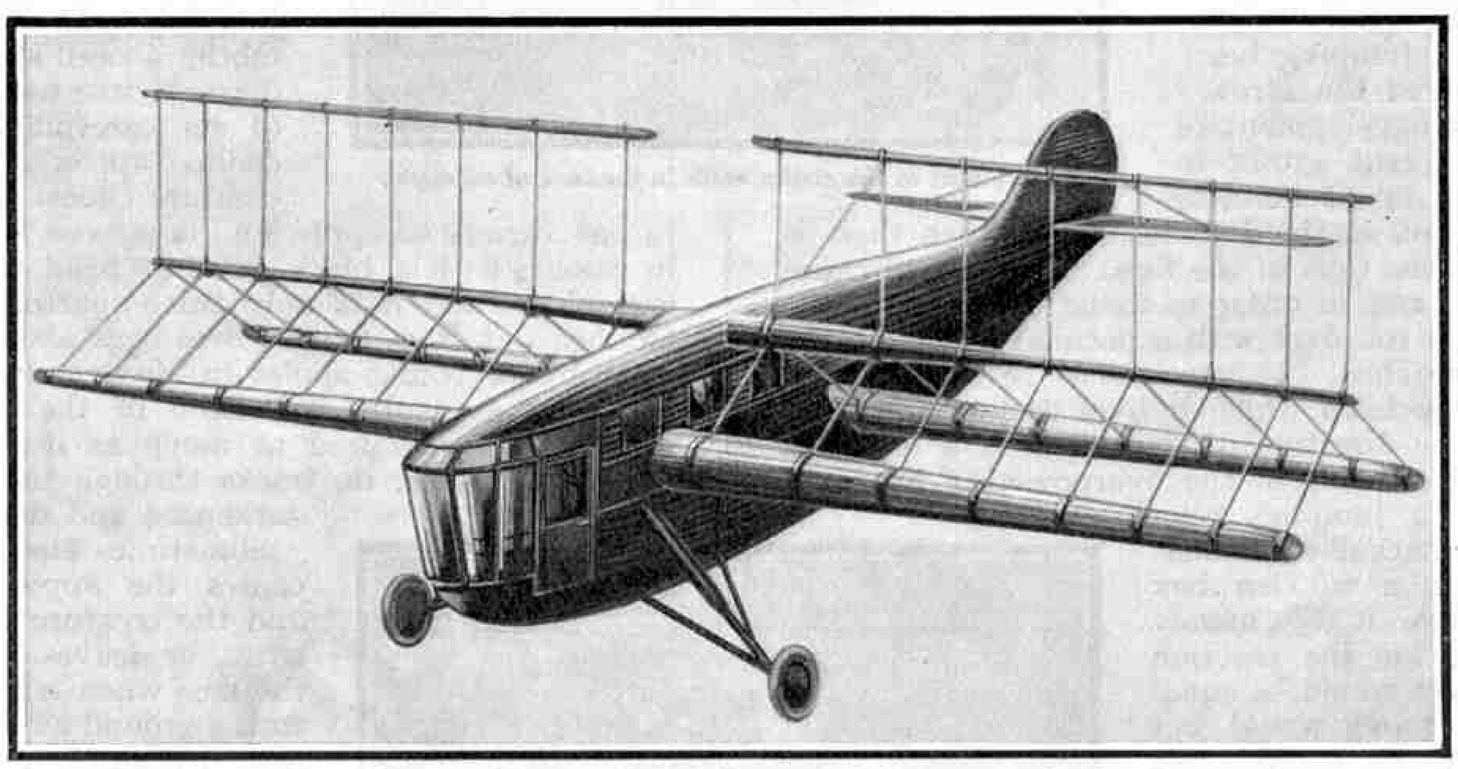
There are four services daily to Brussels and two to Cologne. In both cases passengers from London, on their arrival on the Continent, will be able to establish connections at various points with the whole of the main European airway system. This now comprises lines that cover more than 60,000 miles and enables air journeys to be made to more than 150 towns and cities throughout the Continent, approximately half of these being within a day's flying of London. The speed on these Continental routes is illustrated by the fact that passengers leaving London at four o'clock in the afternoon are able to reach Berlin at 8.15 the same evening.

Another air route which, it is thought, will be very popular this summer, is that to Switzerland. There is a daily service in each direction between London, Basel and Zurich. Leaving London at 8.0 a.m., travellers are able to spend 2¼ hours in Switzerland and return to the London air port by 9.30 the same night !

A Popular French Low Wing Monoplane

Monoplanes of both the low and the high wing types have always been very popular on the Continent, where in fact they outnumber the biplanes. In Germany it is probable that the low wing type is in the majority, but in France high wing monoplanes are most numerous.

One of the most popular two-seater light aeroplanes in use in France is the Farman F-231, a monoplane of the low wing type. This interesting machine, illustrated on the next page, is equipped with a 95 h.p. Renault engine of the four-cylinder in-line type. The wing is of the cantilever type, and consequently there are no bracing struts or wires to detract from the clean design and streamlining. It is of wooden construction, as is also the fuselage. The machine is very low on the ground, the overall height being only 6 ft. 6 in., and this makes it very stable when taxying. The undercarriage is of the divided type to lessen the danger of accident when landing on an uneven surface or in long grass, and the two occupants are seated in tandem cockpits. The machine is 29 ft. 10 in. in span and 20 ft. in overall length, and is capable of attaining a maximum speed of 118 m.p.h., cruising at 99 m.p.h., and landing at about 43 m.p.h.



A novel paddle-wheel aeroplane working on the Rohrbach principle that was developed some years ago as a means of propelling ships. The aeroplane has been designed by a German inventor.

Aeroplane Driven by Steam Engine

An aeroplane that is powered by a steam engine has been designed by a well-known German aeronautical engineer, and is now under construction. A boiler of the revolving type is used, working in conjunction with a steam turbine. The engine drives two airscrews, and it is claimed that the machine will have a non-stop range of between 60 and 70 hours at a speed of 230 m.p.h. at ground level, which would enable a distance of 16,000 miles to be covered on one filling of fuel. The machine will have a maximum speed of 260 m.p.h. at 29,000 ft. and will be capable of carrying a useful load of 2,240 lb. The steam engine is expected to develop 2,500 h.p.

Photographs and a full description of this interesting machine will be published in due course.

American Transoceanic Flying Boat

The first of six flying boats, stated to have been built specially for transoceanic services, has recently been finished in America and has satisfactorily completed its test flights. The machine is the Sikorsky S.42 and has been ordered by Pan-American Airways. It is a four-engined high wing monoplane capable of carrying a crew of five, 32 passengers and their baggage, and 1,000 lb. of mail and express freight. With this load on board the machine has a cruising speed of 150 m.p.h. and a range of 1,200 miles. Its all-up weight is estimated at about 38,000 lb.

An interesting feature of the machine is that the well-known Sikorsky method of construction, which consists of a hull well below the wing and outriggers carrying the tail unit, has been abandoned, and a design similar to that of many British types has been produced. We hope to publish an illustrated description of the machine in due course.

The England-Australia Route

The Government of Australia have now accepted the tender of Qantas Empire Airways Ltd., for the operation of the Singapore-Darwin and Darwin-Brisbane sections of the Empire Air Mail route connecting England with Australia. The sections will be operated by five De Havilland 86 machines. These are claimed to be the smallest four-engined aeroplanes in the world. They are capable of carrying 10 passengers at a cruising speed of 148 m.p.h., and they have a maximum speed of 170 m.p.h.

It is expected that the through service from England will commence not later than December or January next. For the first three months no passengers will be carried on the section of the journey from Singapore to Darwin, as this includes a stretch of 400 miles over the Timor Sea. If after this preliminary period the pilots consider that the risk is negligible, passengers may be carried.

Qantas Empire Airways Ltd., is a new company that has been formed by Queensland and Northern Territory Aerial Service Ltd. and Imperial Airways Ltd.

The Bird's Eye View

The old phrase, "a bird's eye view," has taken on new meaning since the development of air transport. One of the most interesting features of a first trip in an aeroplane is the unusual appearance of the landscape as seen from above. The general flattening-out effect is not very surprising, because it is expected; but many of the other features of the scene are both surprising and striking.

The recorded impressions of travellers by air are interesting to read in comparison with descriptions from ordinary surface travellers. Take, for instance, the many descriptions of the famous African mountain Kilimanjaro. These speak of the towering majesty of the mountain, the upward sweep of its tree-clad slopes, and the clouds that wreath its sides and often obscure its snow-clad summit from the observer far below. That is the view of the ordinary traveller; but a passenger who recently saw the mountain from the window of an Imperial Airways aeroplane flying between Cairo and Capetown received a different impression. "Sitting up there," he tells us, "this wonderful mountain struck me directly I saw it as being exactly like an enormous Christmas pudding covered with white icing." Another interesting account was given by a traveller who, after many journeys to Paris by surface transport, decided one day to make the trip by air. "For the first time," he declared afterwards, "I really appreciated the difference between the appearance of the landscapes of France and England. As you look down on the panorama of south-east England, the winding roads, twisting streams, and the irregular shapes and sizes of the fields, all seem to wind themselves into a sort of crazy quilt pattern. Then, as a contrast, comes the landscape of France, looking from your aerial viewpoint as though it had all been measured out with a ruler and a compass. The French fields are larger. The hedges are fewer. The roads are less winding."

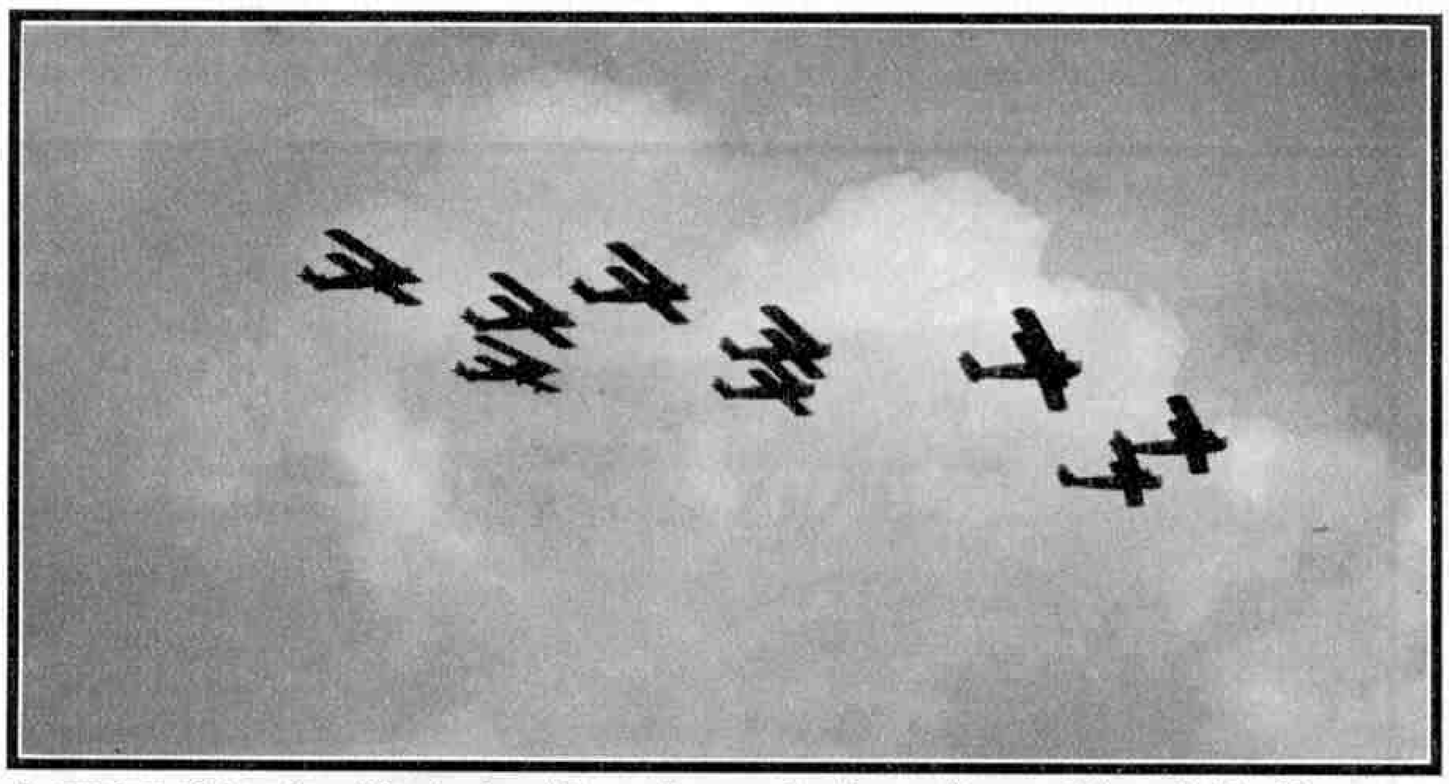
An enthusiastic description has been given by an Imperial Airways passenger who, making a night flight for the first time, saw from his armchair in the saloon the coming of the dawn. "A unique experience this," he writes. "Outside are the wings of the aeroplane surrounded by darkness. Then I look up suddenly to see a soft wonderful glow on the horizon. It is the most beautiful sight I have ever seen—watching this birth of a day from my aerial point of view. We have been flying near mountains, and now I discern their peaks rising faintly above the earth that is otherwise formless, forbidding and indistinguishable. Gradually as I write, the sky changes to a marvellous diffuse pink, making a sight such as artists never see from earth level."

A three-quarter front view of the Farman F-231 low wing monoplane which is equipped with a Renault engine and has a top speed of 118 m.p.h. For this photograph we are indebted to Avions Henri et Maurice Farman.

A Long Glider Tow

Miss Joan Meakin, a young British pilot, recently made a record long-distance towed flight in a glider, travelling from Griesheim, near Darmstadt in Germany, to Cologne, Brussels, Ostend, Lympne and Heston. The flight took about four days, although the flying time was only about two hours a day. Miss Meakin was towed by a German pilot in a Klemm low wing monoplane, and on arrival at Lympne she looped four times when the towing cable was released. She repeated this performance at Heston, looping six or seven times. Miss Meakin is to appear this summer with Sir Alan Cobham's "Circus."

The glider in which the flight was made is a German "Rhonbussard" type, which has been approved for towing by aircraft at speeds up to 74.5 m.p.h. and for aerobatics.



A squadron of American "bombardment" aeroplanes, or bombers as they would be called in this country, flying in formation. Official photograph, United States Army Air Corps.

Fine Records of British Aero Engines

Remarkable evidence of the dependability of British aero engines is afforded by a recent report from the Avio Lines Italiane S.A. of Milan. The company operate air lines over a number of very difficult routes, the Rome-Milan line surmounting the Apennines and the Milan-Munich and the Milan-Zurich lines the Alps. The sudden meteorological changes encountered over these mountains constitute a very severe test, not only to the aircraft and engines but also to the personnel, and only men and material of the highest quality can maintain the service efficiently.

The company use six three-engined aeroplanes fitted with air-cooled Armstrong Siddeley "Lynx" engines. These machines have flown about 1,500,000 miles without accident or untoward incident of any kind, and have never made a forced landing on account of engine trouble. The engines have totalled 33,575 hours running time, which is equivalent to 1,343 hours per engine; and during this time some 20,000 passengers and 350,000 tons of goods, luggage and mails have been dealt with.

These reports are very encouraging from the British standpoint, but they by no means approach the record of dependability and long life set up by the engines in the service of Imperial Airways Ltd. The "Jaguars" used in the "Argosies" of the Imperial Airways fleet have flown 10,489,700 engine-miles in Europe and North Africa, while the "Serval" engines in the "Atalantas" have flown 2,815,952 engine-miles in India and South Africa. In Europe and the Near East the "Lynx" in the Avro 10, and the "Genet Major" in the Westland "Wessex," have flown 1,242,000 and 713,700 engine-miles respectively.

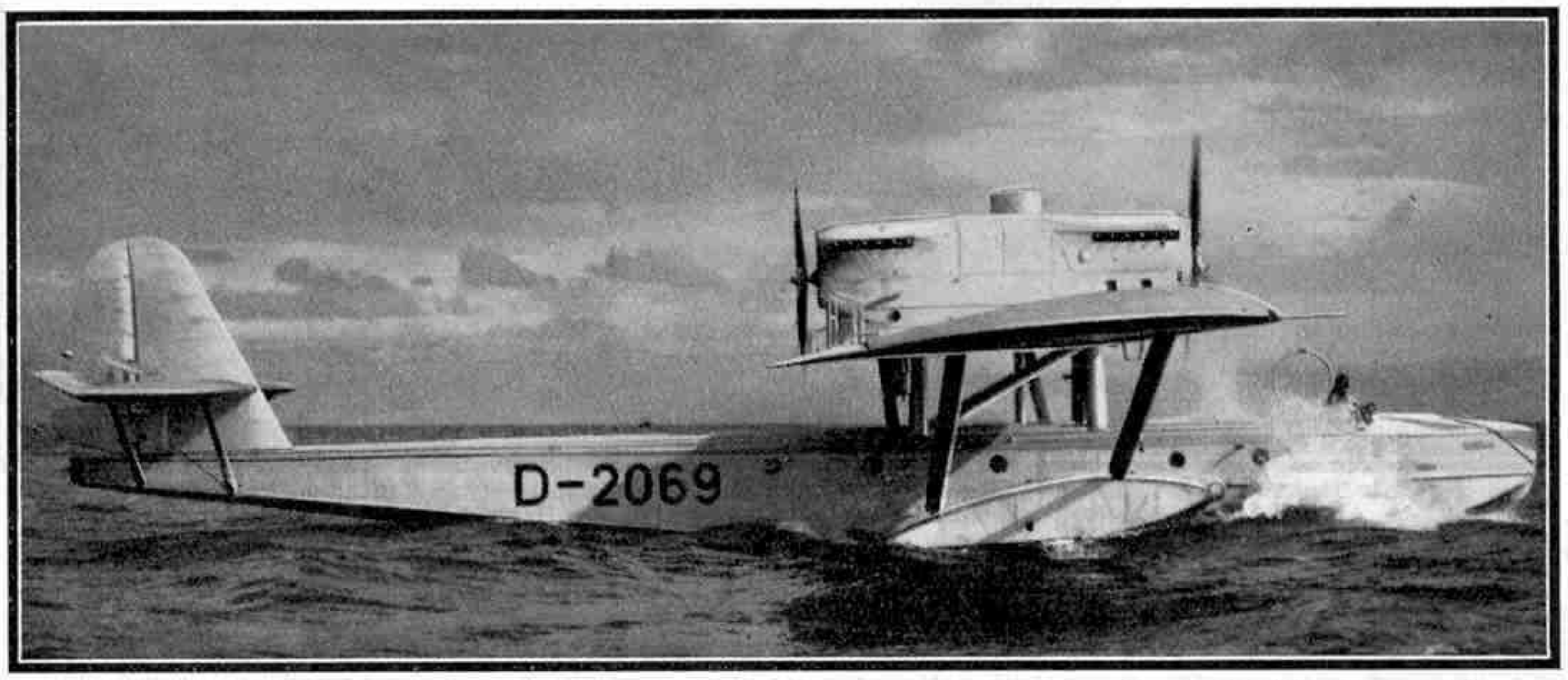
Record for Light Aeroplanes

A new international speed record over 100 km. for light aeroplanes weighing less than 1,235 lb. has been set up in France by M. Raymond Delmotte, flying a new Caudron two-seater machine of the low wing type. The airman covered the 100 km. course, which is approximately 60 miles, in 20 min. 22 sec., giving an average speed of 181.4 m.p.h.

Continental Marine Aeroplanes

Interesting French and German Machines

BRITISH aircraft constructors have always been famed for the marine aeroplanes that they produce, particularly of the amphibian and boat seaplane type. It can be claimed in fact that British marine aircraft are the best in the world, but at the same time it must not be thought that other countries have not produced excellent machines of this type. Germany, for instance, has the largest flying boat in the world, and various French constructors have specialised in the manufacture of small single-engined flying boats and amphibians, a type not often seen in this country. In this article we propose to deal with two interesting flying boats and two amphibians built by Continental firms. The first of these machines is the German Dornier "Wal" twin-engined flying boat; the other three are French machines, the C.A.M.S. 37 and the Schreck-F.B.A. 290, both of the small amphibian type, and the Latécoère 38–0, a flying boat designed for carrying mails.



The Dornier "Wal" taxying along the water. For this photograph we are indebted to Dornier Metallbauten, G.m.b.H.

The Dornier "Wal" is a long-range flying boat that has been developed specially for the transport of mails, freight and passengers over long stretches of water. It is intended principally for the operation of transatlantic services, and therefore it has large-capacity fuel tanks that enable it to travel at cruising speed for a distance of 2,230 miles on one filling of petrol.

The machine is a high wing braced monoplane, but the typical Dornier "sponsons," or stub wings, provided to increase the lateral stability when the boat is on the water during rough weather, give the machine somewhat the appearance of a sesquiplane, or in other words a biplane with wings of unequal span. It is fitted with two B.M.W. VI water-cooled engines each developing 600 h.p., and mounted in tandem in a nacelle arranged above the wing.

The wing is built round two spars similar in appearance to girders, and made of steel. The centre section, which carries the nacelle for the engines, is covered with metal, but fabric covering is used for the structure. The hull is made up of 25 transverse frames linked together by an internal keel and a number of other members running from end to end of the machine. The structural members are all made entirely of metal, duralumin being used except for those that take heavy loads, in which cases high-tensile steel is employed. The hull is divided into seven watertight compartments, and any two of these may be filled with water at any time without causing the boat to sink or to lose its stability.

In the nose of the "Wal" is arranged a watertight collision compartment specially strengthened to take the brunt of the damage in the event of a collision. It is used to store the mooring and sea gear, and access to it is gained through a watertight hatch in the deck. In the latest model of the "Wal" the pilot's cockpit is immediately behind this. There is accommodation for two pilots seated side by side, and the cockpit is completely covered in. In earlier models, however, a passenger compartment provided with seats for eight passengers is situated next to the collision chamber. The pilot's cockpit is behind this, and then there is a second compartment with accommodation for six. If desired the whole of the accommodation may be given up to freight and mails.

The "Wal" is 89 ft. 3 in. in span and 59 ft. 9 in. in length. It weighs 12 tons when fully loaded, and is capable of carrying a load of mails and passengers more than four tons in weight. It has a maximum speed of 143 m.p.h., and a cruising speed of 130 m.p.h., at which speed the range is 2,230 miles.

It is interesting to note that versions of the Dornier "Wal" are built in Italy, Holland, Spain and Switzerland by various companies acting under licence from Dornier Metallbauten, G.m.b.H. In all cases it is available either as a military machine or as a commercial flying boat.

Three Army versions of the C.A.M.S.37 amphibian. Our photograph is published by courtesy of Chantiers Aéro-Maritimes de la Seine.

The first of the two French amphibians to be dealt with, the C.A.M.S.37, is normally a three-seater machine, but is available in a number of versions. It may be obtained as an amphibian or as a flying boat, and also either as a military or a civil machine. The military versions are employed for bombing or coastal reconnaissance in either the flying boat or amphibian types, while there is also a slightly modified variation available as a training machine, which has tandem open cockpits each seating two side by side. A dual set of controls is provided for the two front seats, one of which also has a hood to enable instruction in blind flying to be carried out. The main difference between the civil and military types is that for military purposes a wooden hull is employed, while the civil variation is fitted with a metal hull.

The machine illustrated is an early version of the civil type,

which may be used either to carry freight and mails or as a passenger machine with accommodation for two passengers. It is 47 ft. 7 in. in span and 37 ft. 4 in. in length and, when fitted for service as an amphibian, has a maximum speed of 110.5 m.p.h. and a landing speed of 53 m.p.h. It has a range of 528 miles.

Chantiers Aéro-Maritimes de la Seine, the constructors of the C.A.M.S. 37, are a comparatively new firm in the ranks of aircraft constructors, having been founded in 1921. The firm specialize in the work of designing and producing marine aircraft, and at their test base on the Seine near Paris there are erection shops and slipways capable of taking flying boats up to 10 tons in weight. Bigger craft can be built by the firm, but they have to be erected and flown from a larger base situated near Marseilles. The firm make other flying boats and amphibians in addition to the 37, one of the most interesting having been specially designed for use with the catapults now carried on most light cruisers in the French Navy. It is somewhat similar to the 37, being a two-seater powered with a pusher engine. Its maximum speed is 108 m.p.h. and its range in still air 273 miles.

The four-seater F.B.A. 290 single-seater amphibian that is built by Hydravions Schreck-F.B.A., to whom we are indebted for our photograph.

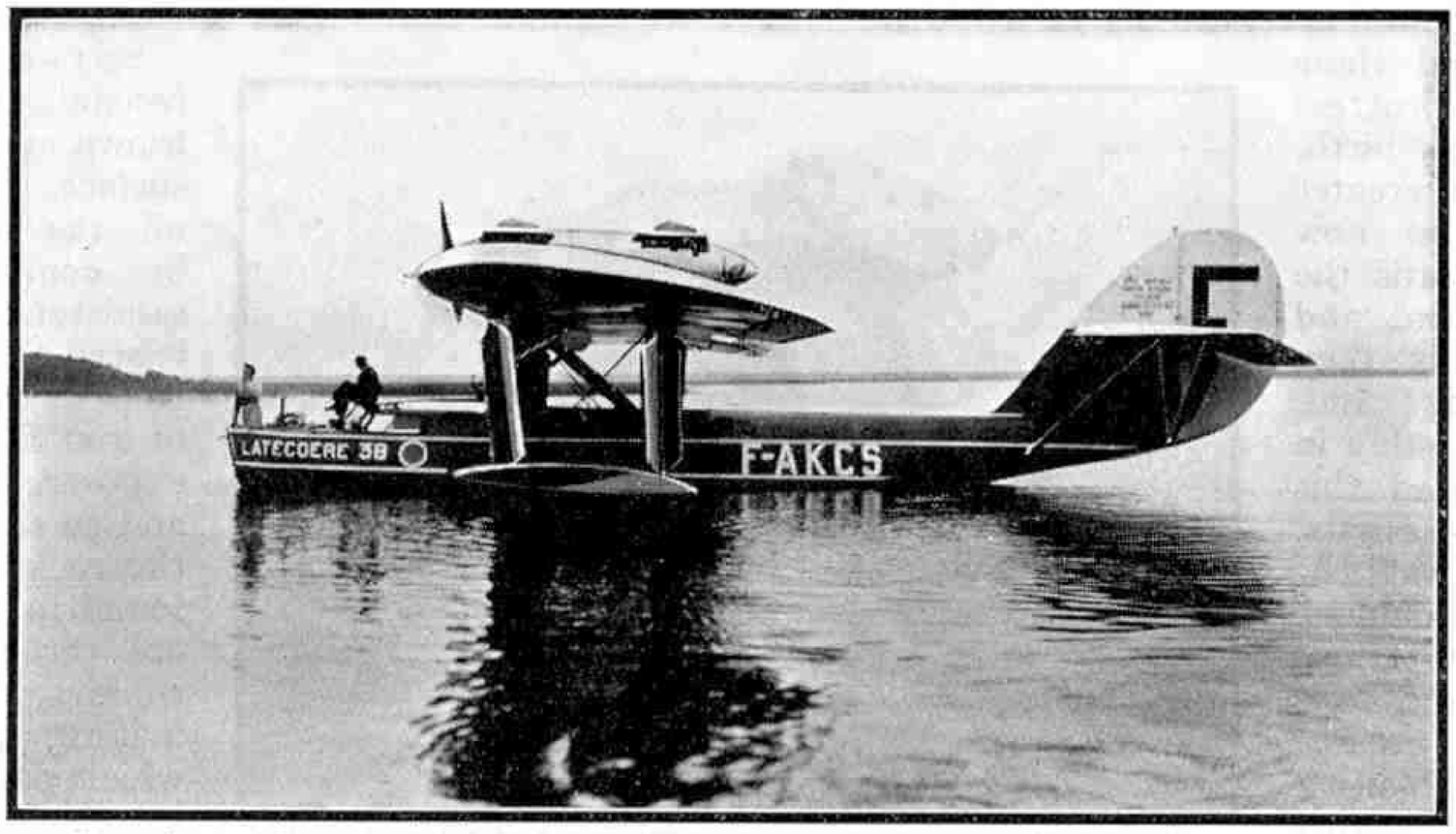
The Schreck-F.B.A. 290 is similar to the C.A.M.S. 37, but it is slightly larger, having accommodation for four. It is intended primarily for civil use, either for the private owner or for carrying out " feeder " air service. It is an unequal-span single-bay biplane made entirely of wood. The cabin is completely covered in, but an excellent view may be obtained from any seat. Access is gained through the windows of the cabin covering, which are arranged to lift up, when they give ample opening. The machine is equipped with a Lorraine " Algol " radial air-cooled engine that develops 300 h.p. and drives a pusher air-screw. It is carried in a nacelle mounted above the hull, nearer the upper wing than the lower one. The fuel is carried in the hull and is fed to the engine by means of a pump.

The F.B.A. 290 is 42 ft. 11½ in. in span and 31 ft. in length, and when fully loaded is 4,400 lb. in weight. Its performance is similar to that of the C.A.M.S. machine previously described, the maximum speed being 105.5 m.p.h., the cruising speed 86.9 m.p.h. and the range 335 m.p.h.

Hydravions Schreck-F.B.A., who build the 290, were well established before the War, and were in fact among the best-known French pioneer constructors of flying boats. Since the War they have specialised mostly in single-engined flying boats and amphibians, and have produced a big range of such machines. Apart from the one we have described, the most popular during recent years is probably the 310, which is a two-seater amphibian of the high wing braced monoplane type. Accommodation for two is provided in a totally enclosed cockpit, and a pusher engine, carried in a nacelle of normal type, is mounted above the wing well out of the way of any spray that may be flung up when the boat alights. The engine employed is usually of the 120 h.p. Lorraine type, which gives the machine a maximum speed of 93.15 m.p.h. and a range of 186 miles.

Our last machine is the Latécoère 38–0, a twin-engined postal flying boat that has seen extensive service on French air lines. It is similar in external appearance to the Dornier " Wal," and is unlike anything built in this country, the nearest approach being the Blackburn " Sydney." It is a high wing braced monoplane and is fitted with two engines arranged in tandem and carried in a single nacelle above the wing. Another feature that adds greatly to its resemblance to the " Wal " is the fact that two small wings are provided on each side of the hull to act as stabilisers, in a somewhat similar manner to the sponsons used on all Dornier flying boats.

The wings of the machine, which are 103 ft. in span, are made of metal, as also is the hull, which is 55 ft. in length and is divided into five watertight compartments. As in the " Wal," a cockpit is provided in the nose for stowing marine gear and for use when picking up moorings. Behind this is a baggage compartment, and then comes the pilot's compartment, which is completely enclosed and is provided with two side-by-side seats with full dual controls. The cockpit connects with a wireless compartment that contains receiving and transmitting apparatus. The petrol is carried behind this compartment on each side of the machine, with a gangway in the middle; and behind the petrol tanks is a rest compartment for the crew, fitted with bunks and various articles of furniture.



This illustration, published by courtesy of Société Industrielle d'Aviation Latécoère, shows the Latécoère 38-0, a twin-engined postal flying boat popular with French air line companies.

Any engines of suitable power can be fitted in the 38, but the standard type is the Hispano-Suiza 12 Nbr 12-cylinder engine of the water-cooled type, developing 650 h.p. The machine has a maximum speed of 130 m.p.h., a minimum speed of 69 m.p.h. and a range of 2,980 miles.

A variation of 38–0 is also produced for use as a military long-distance reconnaissance machine. It is the same in all particulars except the accommodation, which is adapted to meet the highly specialised requirements of a service machine.

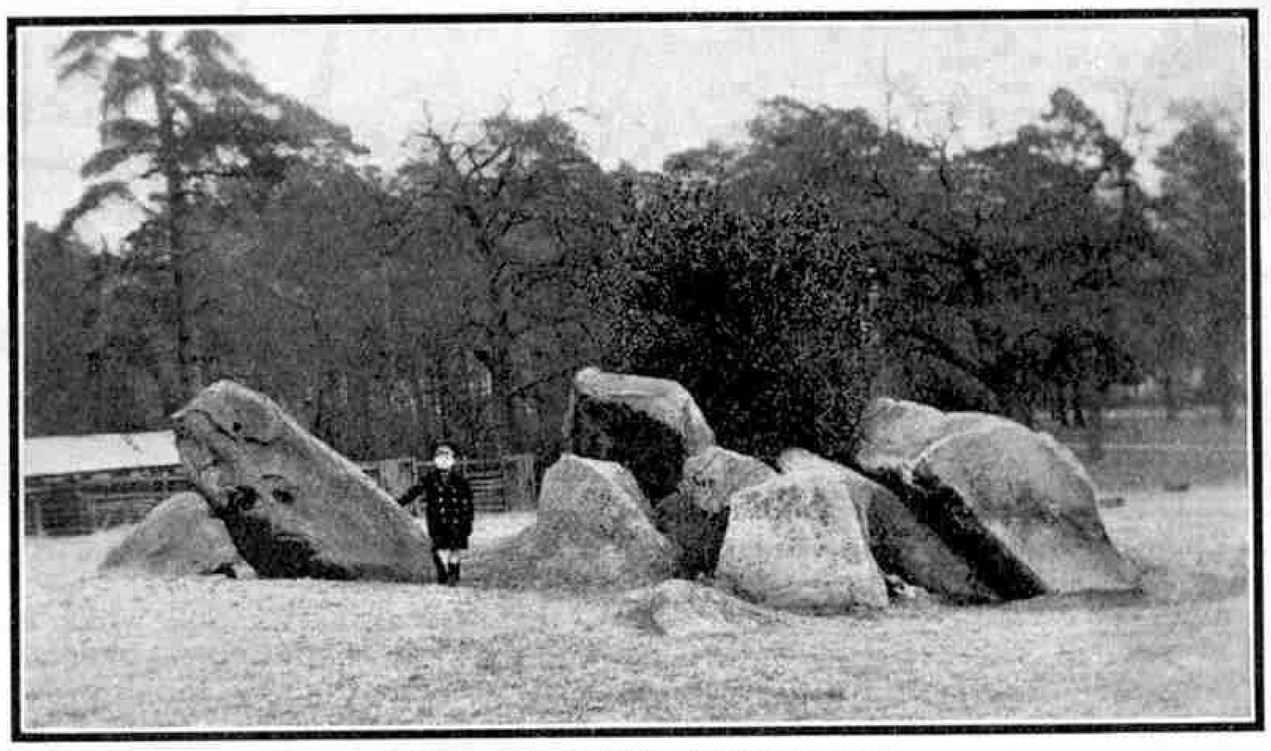
The Latécoère Company are of course well known among French aircraft constructors. Since their foundation in 1917 they have produced a big range of all types of civil and military landplanes and seaplanes. One of the most famous of these, the Latécoère 28, which at one time held 19 world records, was dealt with on page 26 of our issue for January last. It was in a machine of this type that the first commercial crossing of the South Atlantic was made in May 1930, in connection with experimental flights undertaken with a view to operating an air mail service between France and South America.

Life Story of a Sandstone Boulder

A Glimpse of Prehistoric Britain

By W. Coles Finch

A STONE is a mountain in miniature, and it is to fragments of mountains that we owe our knowledge of what befell this world of ours in the vast ages of the dim and distant past. The traces of the earliest forms of life of which we have any knowledge are found in the Cambrian rocks, and as epoch followed epoch the rocks preserved creatures of higher form, from the study of which we are able to trace the grand procession culminating in Man and the creatures now familiar to us.

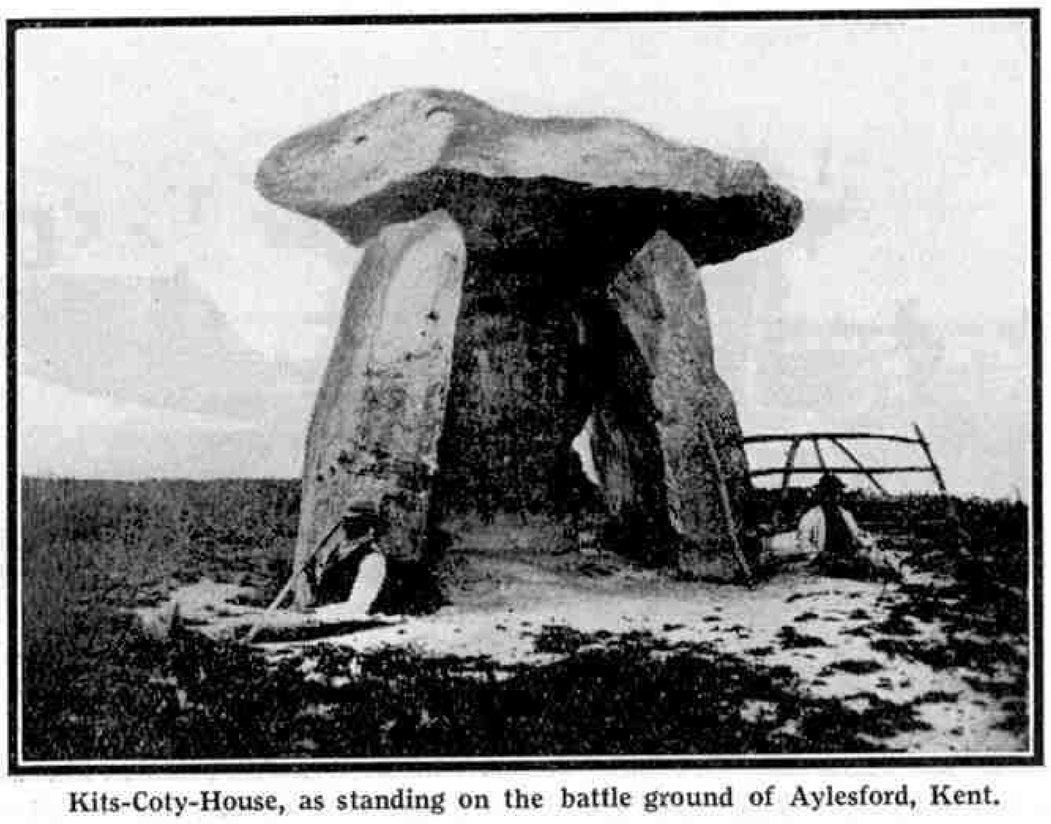


A fallen cromlech at Addington, Kent.

We are concerned here with the boulders of sandstone known as "greywethers" from their supposed resemblance to a flock of wether sheep, or as "sarsens." The name "sarsen" is supposed to be derived from the village of Sarsden, near Andover. Millions of years had passed away, beautiful forms of life already teemed in the ancient seas; lands had been formed, and mountains repeatedly raised, denuded and submerged; and these epochs were still in progress when our boulders saw birth.

Torrential rivers of greater volume than we can now imagine hurried towards the sea, carrying the sand and mud from the lands they were slowly devouring; and, as we see going on to-day in milder form, deposited this material round our coasts. This sand deposit was the birthplace of our boulders. In the course of vast periods of time the thick sand beds thus laid down became buried deeply beneath other beds, the product of further disintegration of the earth's crust. Here slowly but surely began the moulding of our boulders. Iron, lime, or silica occurring in the deposits acted as cementing agents and turned the loose sand into concretionary masses or boulders, which were still buried beneath the ocean depths.

Then came another vast upheaval. Again the ocean bed was raised, and the land peeped above the surface of the sea. Much was ploughed off by the tidal waters, thus bringing our boulders again nearer the light of day. As the tides and storms swept over the newly-raised land, the loose sands were swept away, leaving little evidence of the thick beds they once formed, save in a few places where huge derelicts of stone in the form of the familiar boulders survived the ordeal of the ages, just beneath or peeping through the earth as we see them to-day. Their survival and the purposes they have served in prehistoric times is a romance in itself.



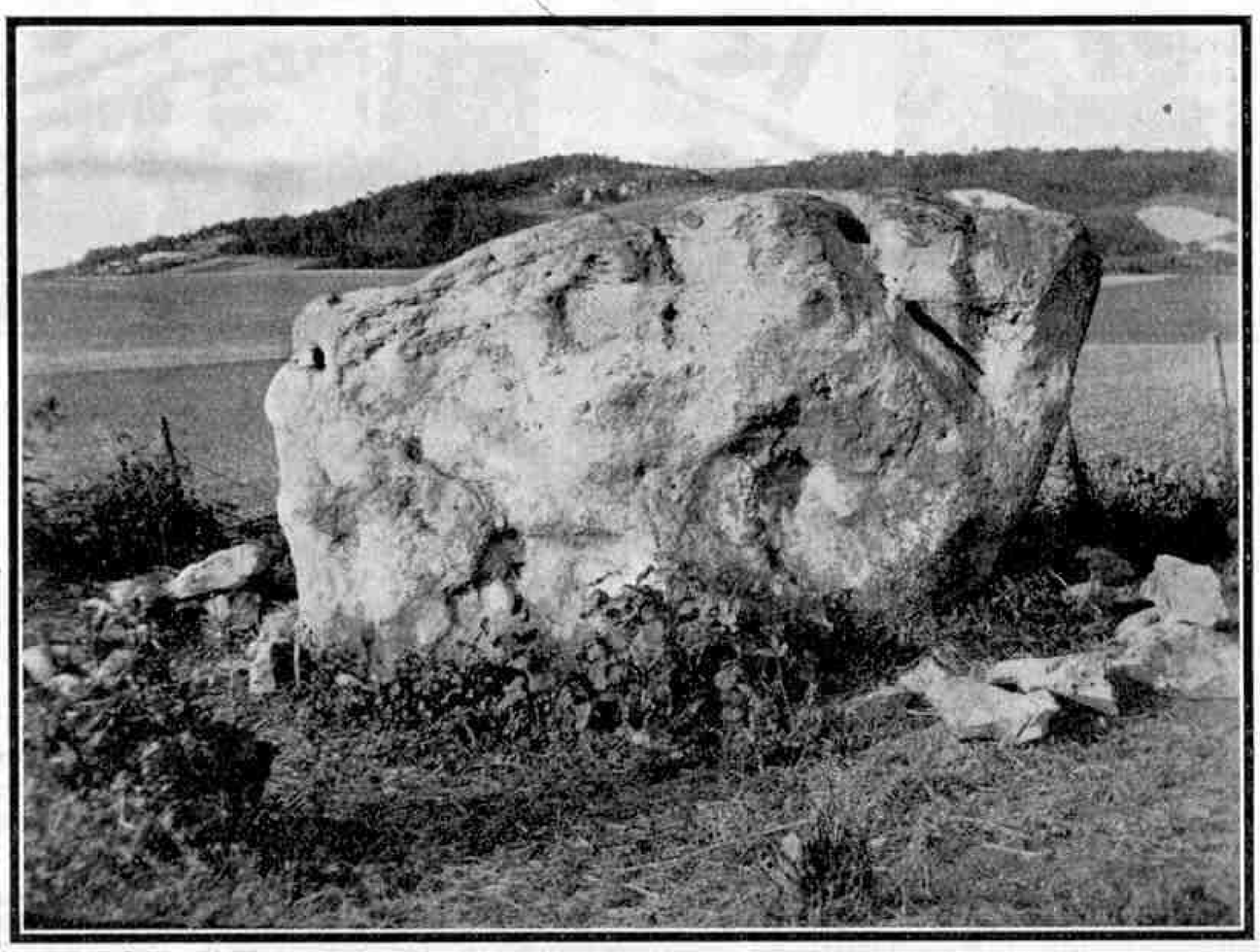
Kits-Coty-House, as standing on the battle ground of Aylesford, Kent.

Huge stones of this type are common, and in the shape of irregular boulders are frequently to be seen lying by the roadside. Some are perforated with quaint pipe-like holes; others are covered with irregular hollows, and wild birds delight to drink and bathe in the tiny pools that collect there in rainy weather. Other boulders assume a peculiar form of surface studded all over by protuberances resembling a mammary or breast-like formation. These are known as mammillated sarsen stones.

Sarsens are easily recognisable by their rich brown and naturally polished surface. If a piece be chipped off, the stones are found to be composed of ordinary sandstone, and their colour is seen to be only superficial. It is in fact due to particles of iron that have oxidised on exposure to the atmosphere, and so stained the surface of the rock. Sarsen stones are found in great numbers, and are broken up for road repairs, or collected for making rock gardens, for which purpose they are very suitable. Sometimes the stones have been built into the structure of local churches, used as gate stops, or as stepping stones across brooks or streams.

The story of the birth of these boulders, here briefly described, is of vital importance, for it is the key to the mystery of the origin of the huge stones that were used by the ancient peoples of Britain for their tombs and altars. The great trilithons of Stonehenge, for instance, are formed of huge sarsens trimmed and squared. The rude and erroneously-called Druidical

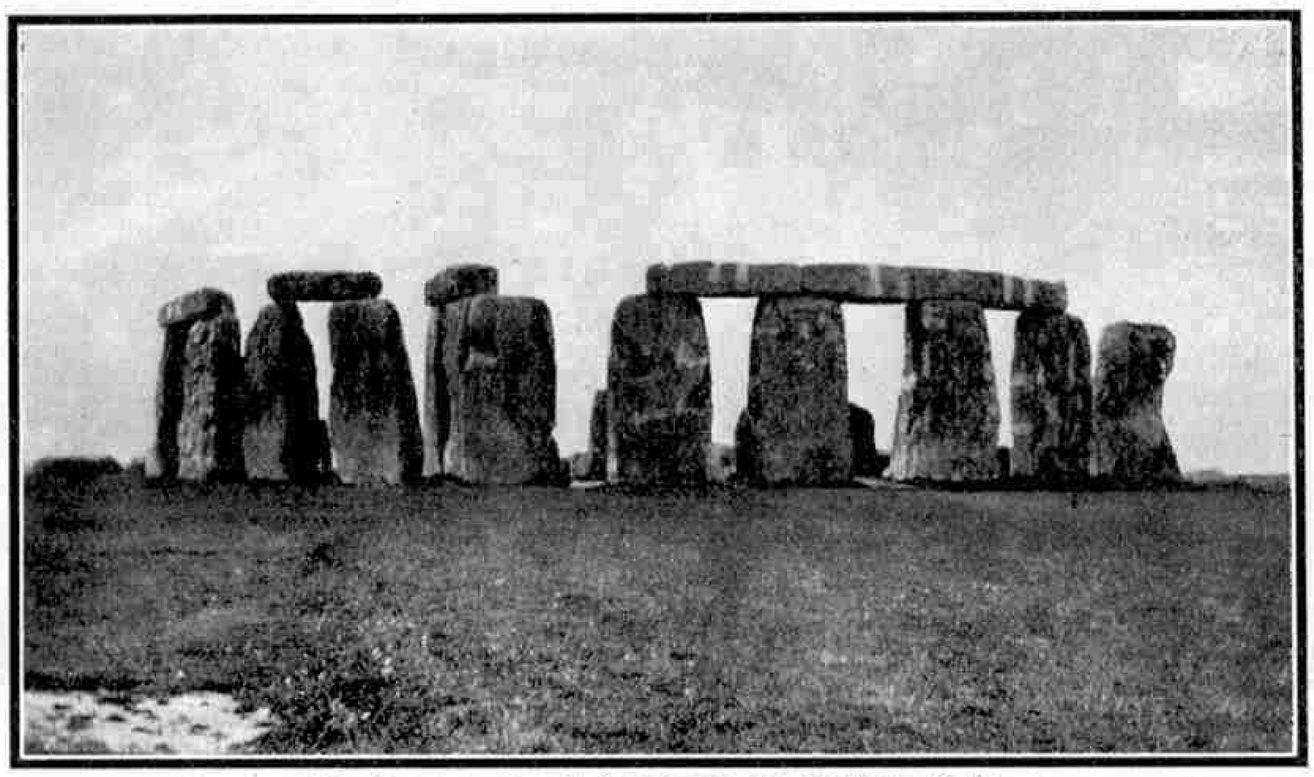
monuments of Kent surpass in age those of Stonehenge, although they are admittedly less imposing. They have suffered greater and more ruthless destruction at the hands of the spoiler than the more perfect structures remaining in other parts of the country. They are of great archæological importance, and they date back to the Stone Age. Let us study briefly these huge rugged upright stones, and the massive horizontal slabs, landmarks of ancient history.



The White Horse stone, a huge sarsen on the Aylesford battlefield.

As the Druids in Britain had the direction of religious matters, these monuments of the past were probably utilised by them for their religious ceremonies, as the idea of continuity of service was then, as to-day, a fascination. The mystery and antiquity of the stones doubtless appealed to the Druids just as to-day we reverence the old and mysterious. It is to be regretted that much of interest in connection with the Druidical religious rites was forbidden to be recorded, and is therefore lost to us.

Such monuments, which are more numerous in the British Isles than is generally supposed, are being slowly demolished by one agency or another, and should be preserved as far as possible, for they are witnesses of the physical strength, mechanical genius, and indomitable perseverance of primitive communities. Whatever toil Man spent at this period upon the abodes of the living, he devoted far more labour and care to the dwellings of the dead. In this way arose the two characteristic forms of Stone Age burial, the cromlech or dolmen, and the chambered cairn or barrow. The wayward fancy of the last two centuries has often pictured the cromlechs as Druidical altars. Perhaps the origin of the legend may be that when their original purposes were forgotten, they were used by the Druids as sacred places. They were undoubtedly grave chambers, and possibly they were used only for the burial of chieftains and their families. They are certainly of the Stone Age, and this appears to be confirmed by the fact that no metal has ever been discovered in them.



The famous ruins at Stonehenge on Salisbury Plain.

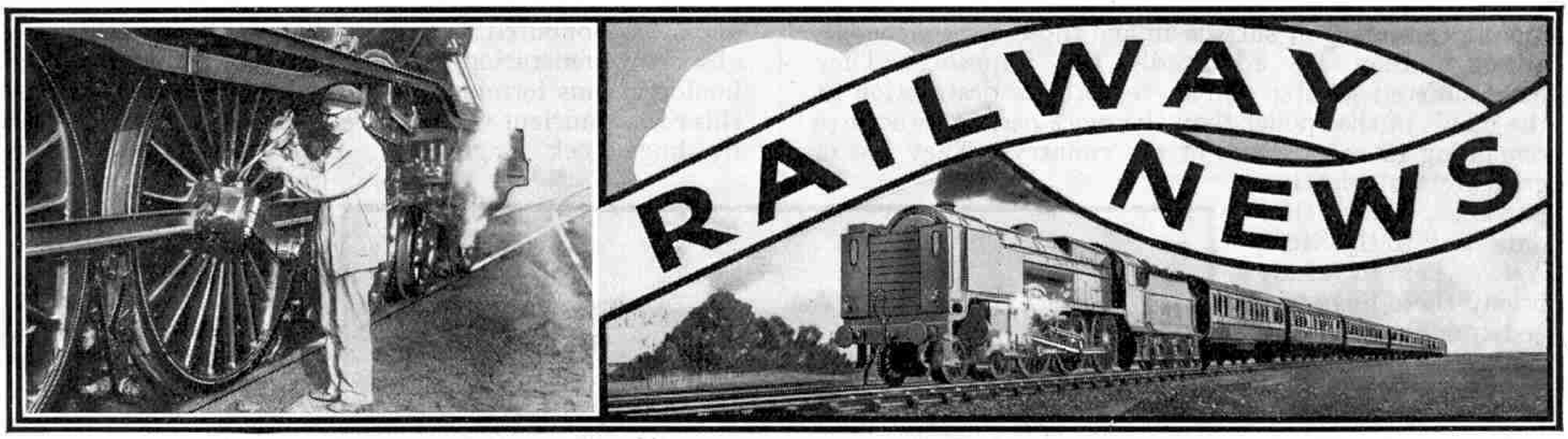
With the slow dawning of higher aspirations, the beauty and mystery of the Sun began to appeal to Man, and stone structures were erected to its honour. Then there was the mystery of water. Our barbarian ancestors honoured it and, as an expression of an all-absorbing veneration, encircled forest pools with huge boulders, thus forming a shrine for water worship. For this reason ancient wells are frequently found surrounded by huge rock fragments. Later, as many of our oldest churches testify, large sarsen stones were built into their structures. Very likely these came from stone circles that had been thrown down, and the sites of ancient stone circles where wells existed appear to have been selected for the erection of many of our churches and some cathedrals. Such relics of prehistoric days as the destroyers of the past have left to us we venerate for the purpose they have served, the links they form in the long chain of the past, and the light they throw upon the state of human intellect in the days before the earliest of which we have any written record.

It has been suggested that " the prohibition to worship stones occurring so frequently in the earlier Christian ecclesiastical laws and ordinances was often the cause of their destruction, for it related, no doubt, to these so-called Druidical monuments. Traces of this worship still remain. In some instances people passed through the Druidical monuments for trial, for purification, or as a mode of defensive charm. In France it is still a practice among the peasantry for young girls who want husbands to climb upon the cromlech called the *Pierre levee*, and place there a piece of money, and then jump down."

It is a matter for lasting regret that generally the work of destruction of these ancient monuments has been so complete. The huge stones built into our churches and houses, or lying half-buried or scattered on the surface, or known to have been broken up, prove that the work of destruction went on to no small extent from the Middle Ages onward, and perhaps only superstition saved the relics that now remain. To-day, unearthed by time and atmospheric denudation, these huge stones still offer themselves for our service ; but now we merely hew them into shape, build them into our churches and bridges, or crush them for road repairs.

We find one little-known form of use for these rough stones, contemporaneous with

(*Continued on page 500*)



L.M.S.R. Locomotives to be Renumbered

With the object of bringing all standard engines into numbers below 10,000, so that eventually, as the older types die out, all five-figure numbers will disappear, the L.M.S.R. are putting into operation a scheme of partial renumbering of locomotive stock. The scheme has been so evolved as to reduce to a minimum the amount of renumbering which has to be done, and well-known types such as "*The Princess Royal*," the "Royal Scots" and the Midland Compounds are not having their numbers altered.

The renumbering will be carried out in three stages. In the first of these 193 engines are being renumbered immediately. Standard engines with numbers above 10,000 and certain others will then be dealt with as they pass through the shops; and non-standard engines will be included in the scheme as their numbers are encroached upon by standard types.

Foremost among the locomotives to be renumbered immediately are the 42 "Baby Scots" or reconstructed "Claughtons," which are to be given new numbers from 5500 upwards, according to the order of their reconstruction. Thus 5971 becomes 5500, 5902 becomes 5501, 5959 becomes 5502, and so on. The numbers of the 70 standard 2–6–2 tank engines undergo a drastic reduction and after being 15500 to 15569 they come down to 1 to 70 inclusive. The 17 locomotives of the former L.N.W.R. 4–6–0 "Experiment" class, having numbers between 5500 and 5552, and 55 locomotives of the same Company's 4–6–0 "Prince of Wales" class, with numbers between 5600 and 5664, are to have 20,000 added to their present numbers. Thus, for example, 5500 will become 25500. The eight existing ex-M.R. 2–4–0 engines having numbers between 1 and 70 are similarly to have 20,000 added to their present numbers. By the same rule the one remaining L.N.W.R. "Jumbo," No. 5001, is to become 25001.

Of the engines to be renumbered gradually as they pass through the shops, the principal are the standard 2–6–0 "Moguls." They are to exchange their present numbers from 13000 to 13284 for new numbers from 2700 to 2984. The standard 0–6–0 tank engines which are variously numbered will all be brought together with numbers 7200 to 7681 inclusive. The older engines at present bearing numbers required for other locomotives under the new scheme will have 20,000 added to their existing numbers to avoid duplication. Rapid progress is being made with the changes, and interesting examples of renumbered engines that have already been observed include Nos. 6, 7 and 8 of the standard 2–6–2 tank class, formerly numbered 15505-7. The original No. 8 of the Midland outside-framed 2–4–0 type used for inspection duties in the Liverpool district, as mentioned on page 209 of the March "*M.M.*," is now 20,008.

A busy scene on No. 1 Platform at Paddington immediately before the departure of the "Cornish Riviera Express." Many famous G.W.R. expresses are despatched from this long platform.

Memorials to Richard Trevithick

Following on last year's celebrations of the centenary of the death of Richard Trevithick, "the father of the steam locomotive," two permanent memorials in honour of that great engineer have been placed on sites with which he was connected, the one at Merthyr Tydfil, where he ran his first railway locomotive in 1804, and the other at University College, London, close to the spot where his locomotive "*Catch me who Can*" drew passengers on a circular railway in 1808. The second of these memorials is a bronze tablet that was unveiled on Monday, 23rd April, by Major the Hon. Oliver Stanley, M.P., Minister of Transport. The tablet is adorned with representations of Trevithick's head and of his London locomotive, and bears the inscription: "Close to this Place RICHARD TREVITHICK Born 1771—Died 1833 PIONEER OF HIGH PRESSURE STEAM Ran in the year 1808 the first steam Locomotive to draw passengers."

New High Speed Trains

The "*Flying Hamburger*" Diesel-electric streamlined train of the German State Railways, with its 77.4 m.p.h. schedule between Berlin and Hamburg, has set a new standard in railway travel that is being followed in several countries in Europe, and also in the United States, where similar trains are being constructed. The most extensive scheme for the adoption of Diesel-electric traction is that of the Netherlands Railways, where no less than 40 new streamlined articulated trains will shortly be put to work, each composed of three articulated coaches.

New Engines for the G.W.R.

A batch of 10 tank engines of the 0–6–0 type, Nos. 9710 to 9719, will be completed and put into traffic early in June. They are similar to the previous 9700–9 series but without condensing apparatus. The next lot to be laid down will be 10 small 0–6–0 tank engines that will be numbered 4830–9. They will be of the same design as the "4800" class turned out a little while ago. These, when completed—probably in July—will be followed by 10 of the small but smart 0–6–0 tender engines of the "2251" class, which will be numbered 2271 to 2280.

The 4–4–0 engines of the "Bulldog" class are disappearing rapidly and seven more have been withdrawn lately for scrapping. They are: No. 3307, "*Exmoor*"; No. 3318, "*Vulcan*"; No. 3331, "*Pegasus*"; No. 3343, "*Camelot*"; and Nos. 3328, 3344 and 3355, which had no names.

New French 2–10–0 Compound Locomotives

The Northern Railway of France are building in their own works some remarkably powerful four-cylinder compound locomotives, having the 2–10–0 wheel arrangement. Of these 30 are on order, the numbers of which will be 5.1201 to 5.1230, the initial figure indicating the number of coupled axles.

Although intended primarily for fast and heavy freight trains, they will also be employed on passenger trains, and some have already been tried with excellent results in regular work on fast expresses. Their 10 coupled wheels are 5 ft. 1 in. in diameter and give very rapid acceleration. In express working speeds of 70 m.p.h. have been attained on the level with trains weighing 550 tons; and with coal trains of over 2,000 tons an average speed of almost 30 m.p.h. has been sustained.

The high-pressure cylinders, which are outside, have a diameter of 19 5/16 in. and a stroke of 25 5/16 in., and drive on to the third coupled axle. The low-pressure cylinders, which are inside, have a bore of 26 3/4 in. and a stroke of 27 9/16 in., and drive on to the second coupled axle. Piston valves, operated by Walschaerts gear, are used for all cylinders. The boiler has a total heating surface, including superheater of 2,764 sq. ft., and a working pressure of 261 lb. per sq. in. The grate has an area of 37.4 sq. ft. The weight of the engine in working order is 102 tons 7 cwt., the adhesion weight being 88 tons 11 cwt. The tender has a water capacity of 8,360 gallons and a coal capacity of 9 tons.

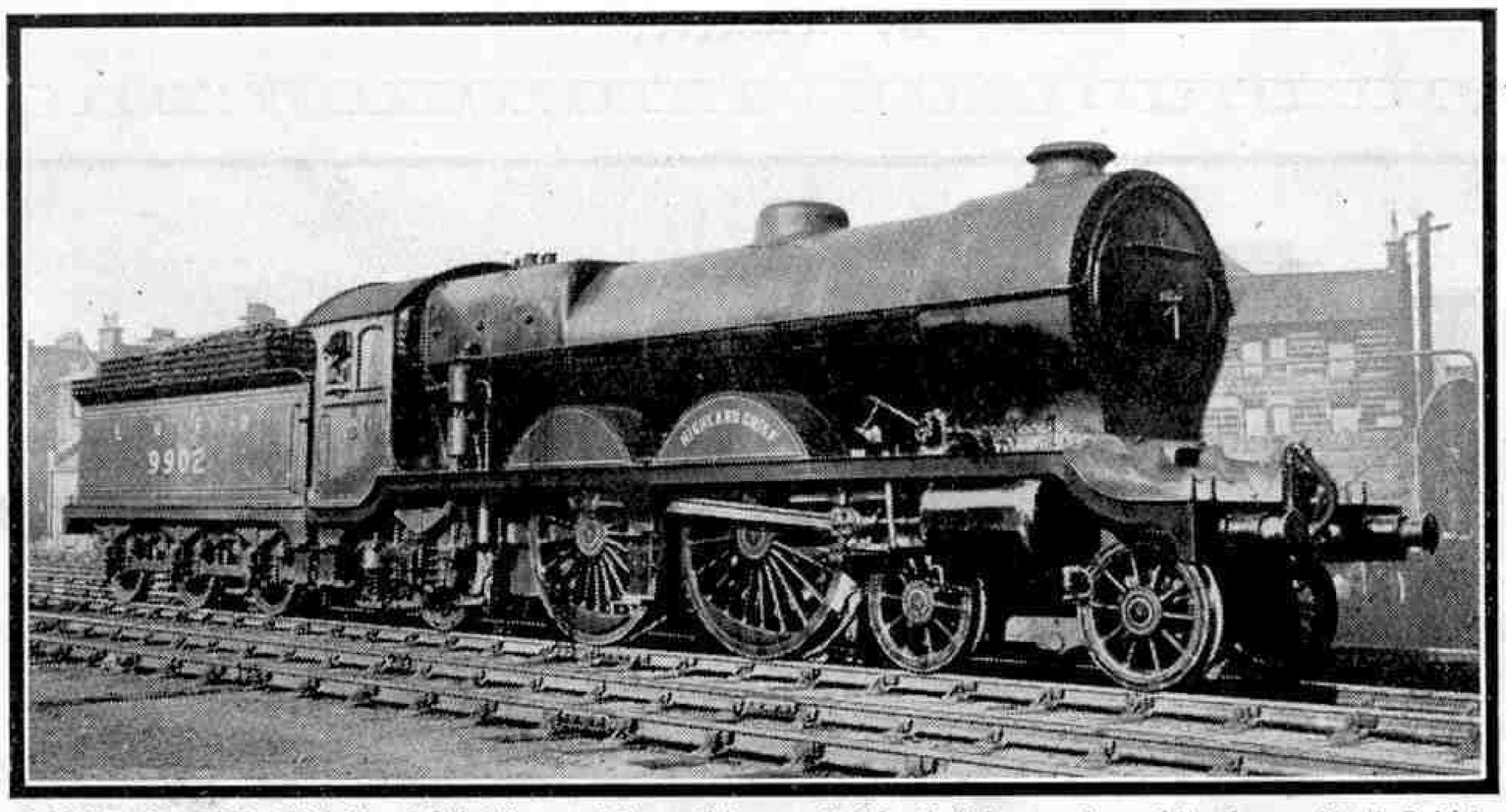
Express Freight Trains on the S.R.

The S.R. are now running nightly a completely braked freight train from London (Nine Elms) to Exmouth Junction at a really express speed. The train is usually made up of 49 wagons and a brake van and, leaving Nine Elms at 10.15 p.m., it covers the 82 miles to Salisbury in 1 hr. 46 min., its average speed being nearly 50 m.p.h. From Salisbury it runs non-stop to Exmouth Junction and for the 86 miles over this heavily-graded road, 2 hr. 20 min. are allowed. From 9th July next, when the new service will have been thoroughly tested, it is intended to cut the time between London and Salisbury by a further 5 min.

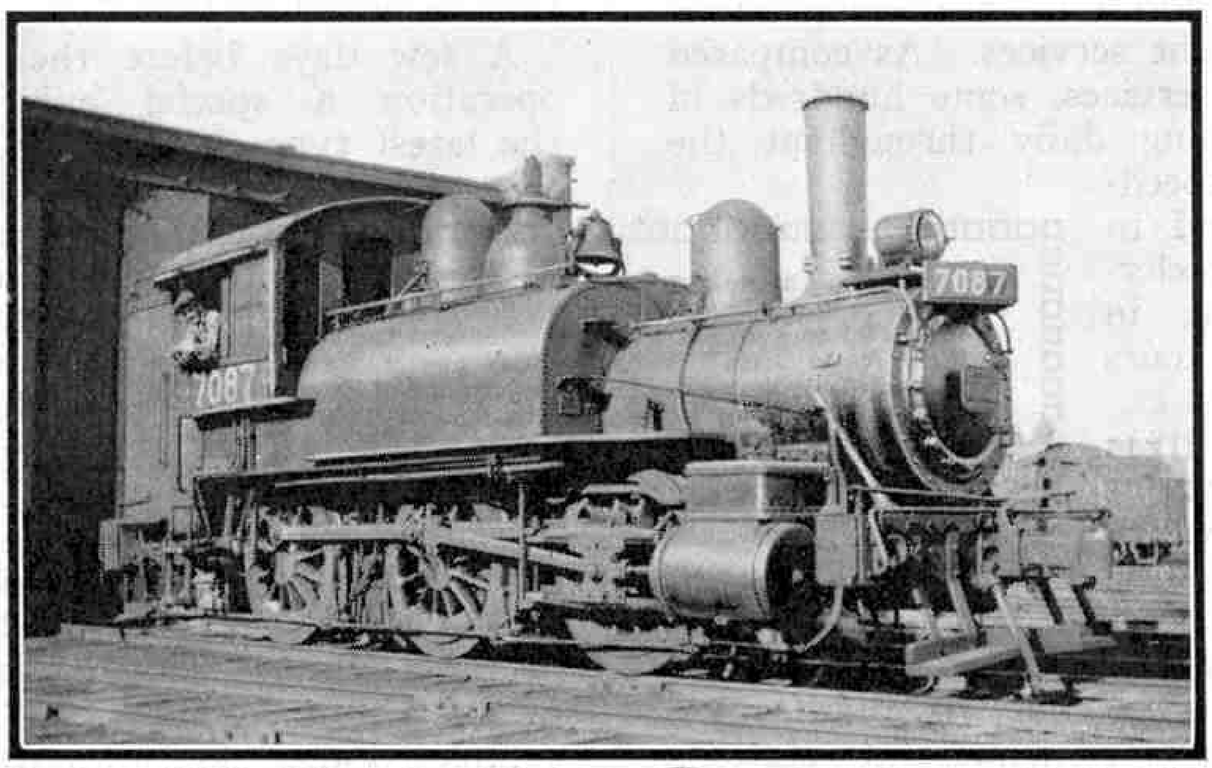
L.M.S.R. Locomotive News

The last series of "Baby Scot" 4–6–0 express engines with parallel boilers has been completed at Crewe. They are numbered 5542 to 5551. The succeeding engines of this 5.X class will be of a modified type with tapered boilers and the first of them, No. 5552, is illustrated and described on page 470 of this issue.

Two more engines of the "Claughton" class have been taken out of service. They are: No. 5928, "*Charles H. Dent*," and No. 6021, "*Bevere*."



L.N.E.R. No. 9902, "Highland Chief," one of the well-known "Atlantic" locomotives of the former North British Railway. For many years these engines have performed much hard work on the "Waverley" route between Edinburgh and Carlisle and on the main line to Aberdeen.



A veteran of 1884 still in service. This 0-6-0 saddle tank locomotive was originally built for the former Grand Trunk Railway of Canada, and is now used about the roundhouse and shops of the Canadian National Railways at Toronto. Photograph by James Simmons of Toronto, Canada.

Tunnelling the Apennines

A valuable addition was made to the railway services of Italy by the opening on 22nd April last of the new direct electric line between Bologna and Florence. This is 61 miles long, and has cost £17,000,000, owing to the large amount of tunnelling required in crossing the Apennine range. The longest bore, which is known as the great Apennine Tunnel, exceeds 11 miles in length. Midway through it, there is a station with additional tracks so that slow trains can be shunted for expresses to pass. By means of the tunnels, very steep gradients are avoided and the highest altitude attained is 1,064 ft. This direct route effects a saving in time of about 90 min. as compared with the older, steeper and longer lines that go over the mountains. This new line was first planned more than 50 years ago but work was not begun until 1915. Progress was interrupted by the Great War but it has gone forward steadily since 1919.

London Transport Improvements

The London Passenger Transport Board has already taken some steps towards improving the railways under its control and harmonising them to its adopted standards. Some of the ex-"Metropolitan" carriages have been repainted in the bright "Underground" livery of red and cream in place of the former more sober brown colouring. The interiors have also been redecorated in a tasteful scheme of blue and cream, together with new upholstery and fittings and better lighting. Several "Circle" trains are running thus transformed and all will be so treated in turn.

On the Great Northern and City line there is now only one class instead of two formerly. An important scheme to simplify and improve the connections between the stations at Moorgate is about to be carried out.

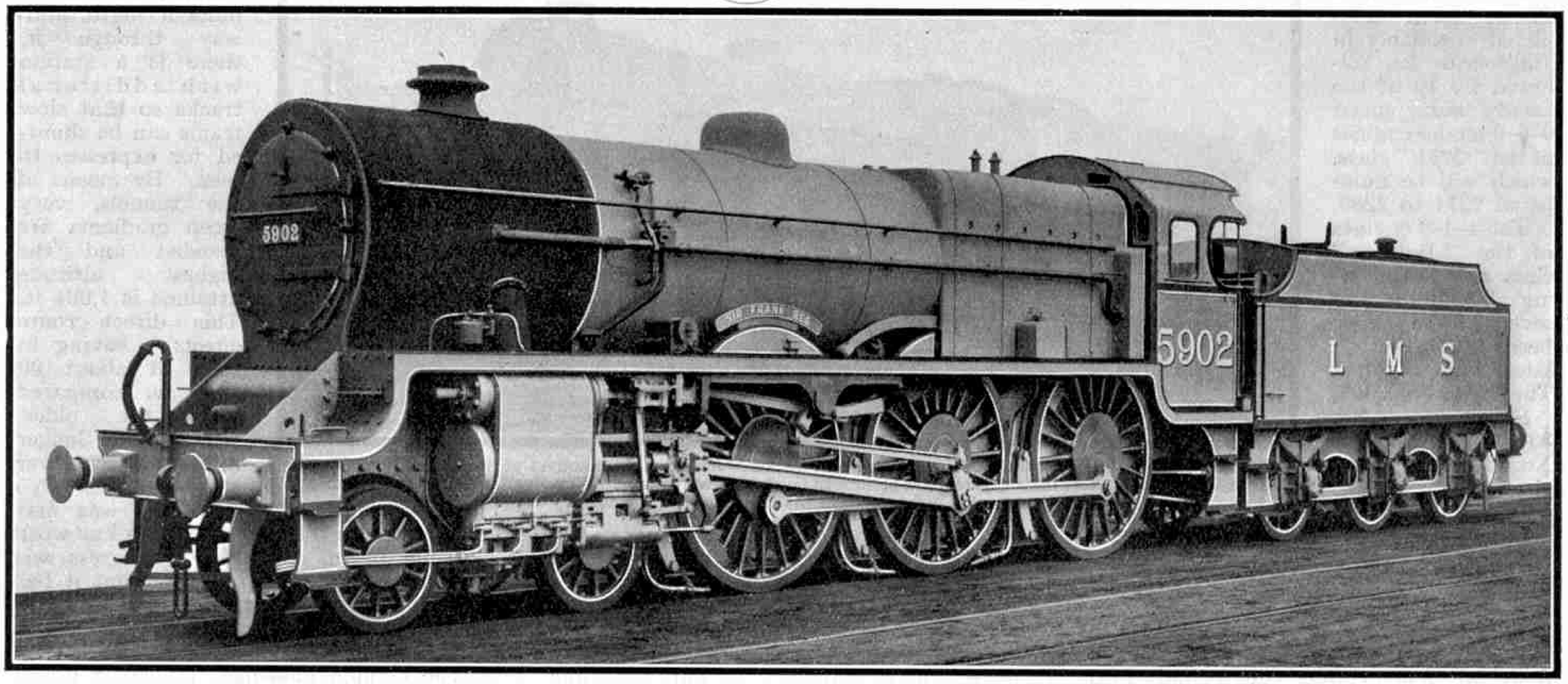
Eight Beats or Four?

The S.R. 4–6–0 four-cylinder express locomotives of the "Lord Nelson" class were all built with their cranks set at such angles to one another as to produce eight puffs of the exhaust for each revolution of the driving wheels. Recently one of them, No. 865 "*Sir John Hawkins*," has had its cranks altered and set at the more usual angle of 90 deg., however, with the result that the eight beats have been reduced to four. It was claimed that the more rapid puffing produced a very even, sustained blast on the fire but it will now be possible to ascertain whether there is any definite advantage in this crank setting.

Improved Services on the L.M.S.R.

New Series of 113 "Baby Scot" Locomotives

By "Observer"



THE latest programme of new construction and improved services adopted by the L.M.S. Railway is a sure indication of the enterprise of that company and of the better day that is dawning for the railways. No less than 232 new locomotives and 674 new coaches are being built by or for the L.M.S.R. this year, and extensive additions are being made to both passenger and freight services. As compared with the previous winter services, some hundreds of additional trains are running daily throughout the L.M.S.R. system. Further speeding up has been done, and in all 479 trains have been accelerated, with a total saving in journey times of over 28 hours daily.

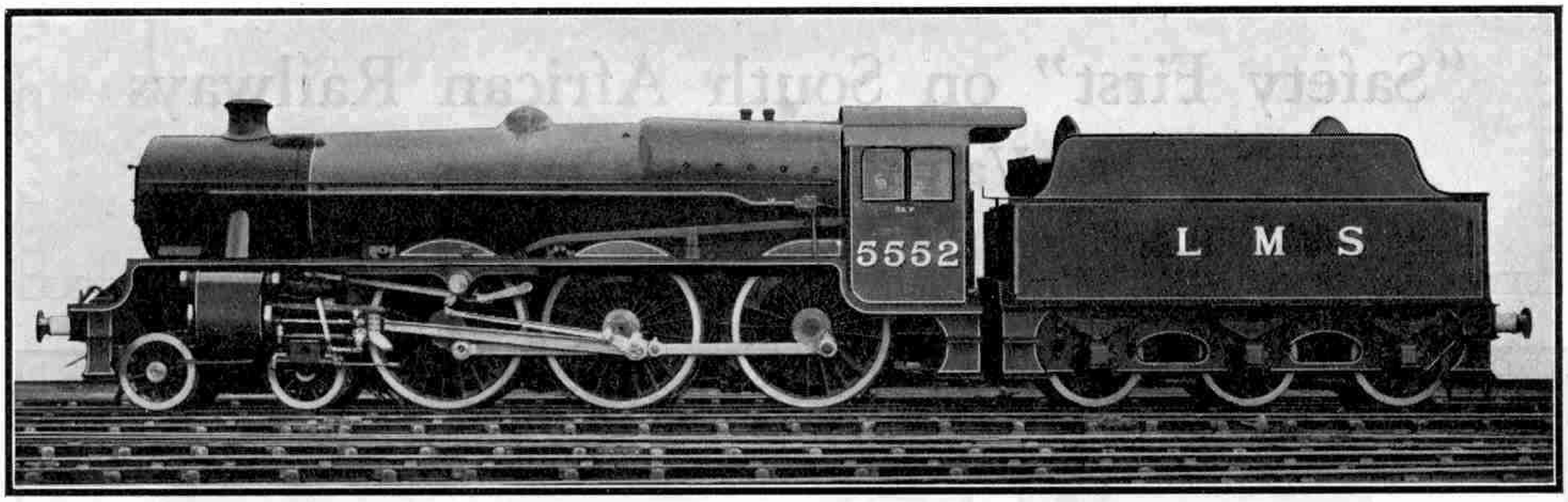
The most important train affected by the accelerations is "*The Irish Mail*," which now leaves Euston at 8.45 a.m. instead of 8.30 a.m. as before. In place of the time-honoured call at Willesden, a stop is now made at Watford, and for the 65.5 miles from there to Rugby 70 minutes are allowed. By means of reduced times at stations and smarter running, Holyhead is still reached at 2.5 p.m. as formerly, so giving an acceleration of 15 minutes in the overall time. "*The Mid-day Scot*" is 5 minutes faster from Glasgow and Edinburgh to London, while the express services from Liverpool and Manchester to Glasgow and Edinburgh, and vice-versa, have been accelerated by from 13 to 20 minutes per train. Extensive accelerations have been made also in Scotland.

As against these quickened services certain trains have been decelerated, the most notable being the 11 p.m. express from Euston to Edinburgh and Perth, which now starts at 10.50 p.m. and has 179 minutes to Crewe instead of its former allowance of 169 minutes. On the Midland Division many of the principal expresses are slowed considerably on Saturday in order to secure more punctual working with the heavier loads that are usual on that day.

A few days before the new timetable came into operation a special exhibition train, representing the latest types of L.M.S.R. locomotives and coaches, was brought to Euston, where it was open for inspection by the company's officials and representatives of the Press. At the head of the train were two brand-new locomotives, the leading one being No. 2500, the three-cylinder 2–6–4 tank engine that was illustrated and described on page 391 in last month's "*M.M.*" The second engine was No. 5552, the first of a new series of three-cylinder 4–6–0 express passenger locomotives of the 5X or "Baby Scot" type, that had just been completed at Crewe to the designs of Mr. W. A. Stanier, Chief Mechanical Engineer of the L.M.S.R.

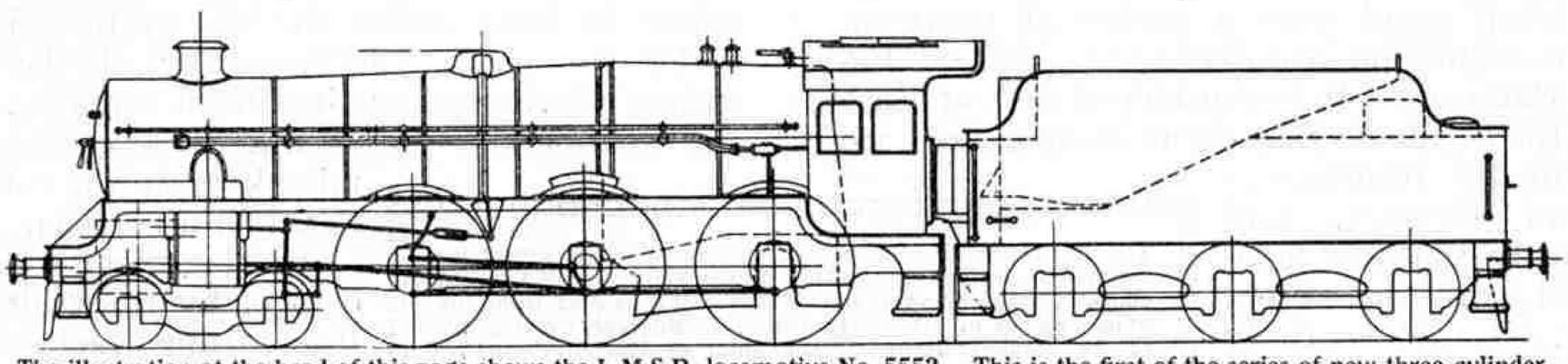
To me the most interesting feature in the exhibition train was the new express locomotive No. 5552. The earlier "Baby Scots," or reconstructed "Claughtons," the first two of which were put into service in 1930, have won for themselves an enviable reputation that doubtless will be maintained by their successors, and as 113 of this new series are being built this year, they will soon be among the most numerous locomotives running in Great Britain. A first lot of five, numbered 5552 to 5556, are being turned out from the

The photograph above shows L.M.S.R. No. 5902 "Sir Frank Ree," one of the first of the original "Claughton" class to be reconstructed as a three-cylinder locomotive. The similarity to the "Royal Scots" in the general appearance of the reconstructed engines resulted in the application of the popular title of "Baby Scots." The illustrations to this article are reproduced by courtesy of the L.M.S.R.



works at Crewe. Fifty more, Nos. 5557 to 5606, are under construction at the North British Locomotive Company's works at Glasgow. Forty-eight further engines of the class, Nos. 5607 to 5654, are about to be put in hand at Crewe; while a batch of ten, Nos. 5655 to 5664, will be built at Derby works, making the total of 113.

From the official photograph reproduced on this page it will be seen that, although the new engine conforms generally to the design of the earlier "Baby Scots," there are numerous modifications, the most noticeable being the substitution of a tapered boiler for the former parallel one. From a minimum diameter of 5 ft. the barrel increases to a maximum of 5 ft. $8\frac{3}{8}$ in. The centre line of the boiler is 8 ft. 11 in. from rail level, $\frac{1}{2}$ in. lower than before. The working pressure is 225 lb. per sq. in., an increase of 25 lb. Following Mr. Stanier's practice, no steam dome is provided, but only a cover—not a very shapely one—for the top-feed valves. The chimney is of the new standard pattern and distinctly longer than those previously fitted to "Baby Scots." This added length, together with the tapered boiler, renders it unnecessary to fit smoke deflector sheets. The whistle is of the type adopted by the L.M.S.R. as standard for all new engines.



The illustration at the head of this page shows the L.M.S.R. locomotive No. 5552. This is the first of the series of new three-cylinder 4–6–0 engines now being put into service. They have been developed from the "Baby Scots" and have tapered domeless boilers and a different type of cab. The lower illustration is a diagram of the general arrangement of the new locomotive.

The cab is more commodious and has two sliding windows on each side. The drive is on the left side and all the controls are arranged for convenient handling. Tip-up seats are provided for the driver and fireman. On each side of the cab there is a small hinged window that acts as a draught preventer for the enginemen when looking out.

The three cylinders are 17 in. in diameter instead of 18 in. in the earlier engines; the stroke of 26 in. is the same. Walschaerts valve gear is fitted, a separate set being provided for each cylinder. The wheel diameters are as before—3 ft. 3 in. for those of the bogie and 6 ft. 9 in. for the coupled. The total wheelbase remains the same but slight alterations have been made in the distances between wheel centres, 2 in. more being allowed between the middle and trailing coupled axles, and 1 in. less between the middle and leading coupled axles, and between the leading coupled axle and the trailing axle of the bogie. The heating surface, alike in the tubes, fire-box, and superheater, shows a slight reduction, the total in the new engine being 1,852.4 sq. ft. as against 2,098 in the original "Baby Scots." The grate area is 29.5 sq. ft., a reduction of 1 sq. ft. Notwithstanding these slightly reduced dimensions there can be no question that the new boiler will be equal to the older one as a steam raiser. The increase in working pressure also ensures that, although the diameter of the cylinders has been reduced, there is an increase in the tractive power which, at 85 per cent. of the boiler pressure, is 26,610 lb. instead of 26,520 lb. in the earlier design.

The general fittings of the new engine are in accordance with the company's standard practice. Two pop type safety valves of $2\frac{1}{2}$ in. diameter are placed at the crown of the fire-box. The main regulator is incorporated in the superheater header in the smoke-box. A steam manifold is provided on the top of the fire-box doorplate in the cab, on which are provided the necessary valves for the injectors, ejector and steam brake, carriage warming apparatus, whistle, pressure gauge, and sight feed lubricator to regulator.

The tenders for the new engines are of two sizes. Those that are being built at the company's works at Crewe and Derby will carry 3,500 gallons of water and 7 tons of coal, while the 50 built by the North British Locomotive Company will carry 4,000 gallons of water and 9 tons of coal. Both sizes will be of the six-wheeled type but the smaller tender will have a wheelbase of 13 ft. and the larger a wheelbase of 15 ft. The bunkers have been carefully arranged so that as far as possible the coal will be self-trimming. The water pick-up apparatus is of the standard pattern.

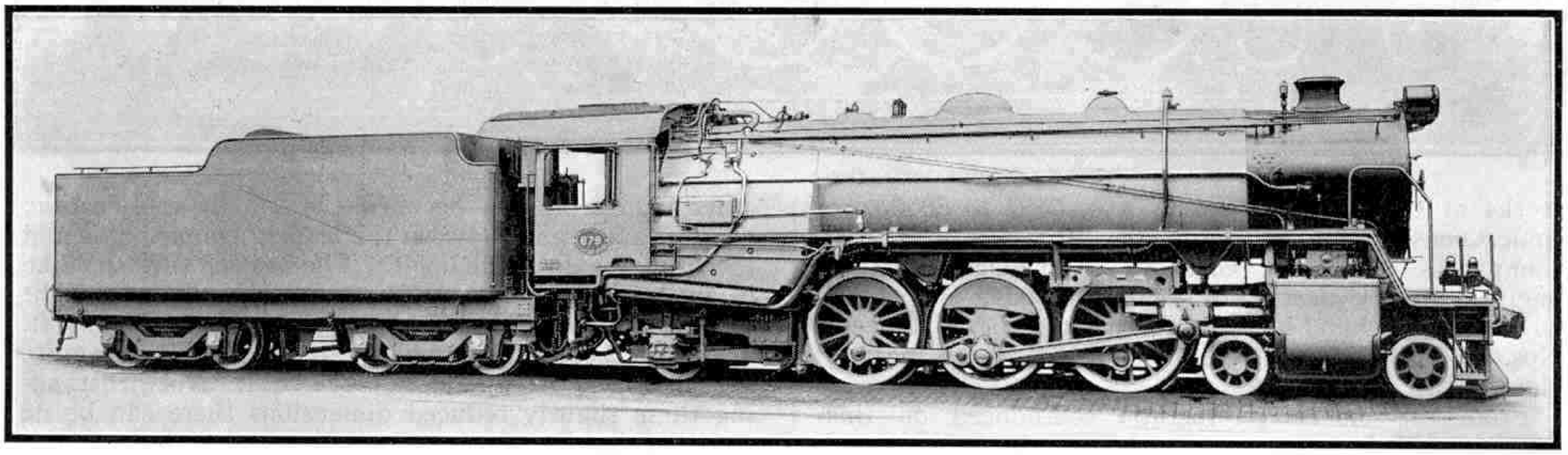
The overall lengths of the engines and tender are, with 3,500 gallon tender, 62 ft. $8\frac{3}{4}$ in.; with 4,000 gallon tender 64 ft. $8\frac{3}{4}$ in.

The weight of the engine in working order is 80 tons, 15 cwt., of which almost 60 tons are carried by the coupled wheels. Together with one of the bigger tenders, fully loaded, the total weight is 134 tons 17 cwt.

"Safety First" on South African Railways

The Value of Track Circuits

By A. H. Betteridge



The illustration above shows 4-6-2 locomotive No. 879 of the South African Railways. This engine is fitted with Caprotti poppet valves and gear and differs in this respect from the other engines of Class "16 DA." Photograph by courtesy of the builders, Henschel and Sohn of Kassel, Germany.

IN South Africa, as in other countries, railway practice is always in favour of methods to ensure more and more safety in working. No industry in the world takes greater pains than the rail transport industry to ensure safety for the public and for their employees. No cost is too great to maintain in the public mind the feeling of security that railway travel gives, and the railway managements of the world spend millions of pounds annually for the sole purpose of guarding against possible accidents. In South Africa alone, nearly £2,000,000 is being spent over a period of years on modernising the signalling installations in use on the South African Railways. It is considered that at least 95 per cent. of the accidents that occur on open lines are directly or indirectly attributable to the human element, and hundreds of costly schemes have been introduced with the object of minimising, if not entirely eliminating, this factor.

It is believed that by means of the latest signalling devices, particularly the electric improvements, the old enemy "human element" will virtually receive its death-blow as far as train-operating is concerned. An interesting instance of the improved methods brought about by modern conditions is found in the installation of colour-light signals at Capetown station and yard, and on the Capetown suburban lines. Complete power equipment has been provided in place of the mechanical system previously in use; in Capetown station, for instance, one power-operated signal cabin replaces two mechanical cabins. On the electrified suburban lines the headway between trains has been reduced from 2½ minutes under mechanical conditions to 90 seconds under the new arrangements. The introduction of the electrically-operated automatic signalling system was, indeed, necessary to enable the fullest advantage to be taken of electrification in increasing the capacity of the line.

Track circuits are a feature of this signalling installation both in the yard at Capetown and on the suburban lines. Altogether these circuits number 230, and 60 of them are in use on Capetown station yard. The provision of track circuits has probably done more than any other invention to eliminate the risk of forgetfulness in the operation and control of train movements. The system enables the signal levers in a cabin to be locked electrically, immediately an engine or other vehicle occupies a line or fouls the points leading to another. Until the trailing vehicle of a train has passed a fixed clearance point, an adjacent road thus fouled, which might be used under the old system, is safeguarded under the new. The ingenuity of the track circuit system prevents the points from being set for this road, and this makes it impossible for a signalman to make a mistake from the cabin that might result in a collision.

Another point is that with signal control by track circuit in operation trains actually safeguard themselves by causing the home signal to regain the danger position automatically when the train has passed it. This form of protection is secured by the train disturbing the track circuit to the signal after it has entered the section or road to which the signal applies.

There are certain practices on the South African Railways that are peculiar to the country. Points are operated from the lever frame in the signal cabin by wire, except in the case of power-operated points. Continental railways follow this system also, but British and American railways generally use rods for this purpose. Another detail is that in South Africa the outer home and distant signals are invariably placed on the same signal post, in contrast to the practice of most other railways in the world.

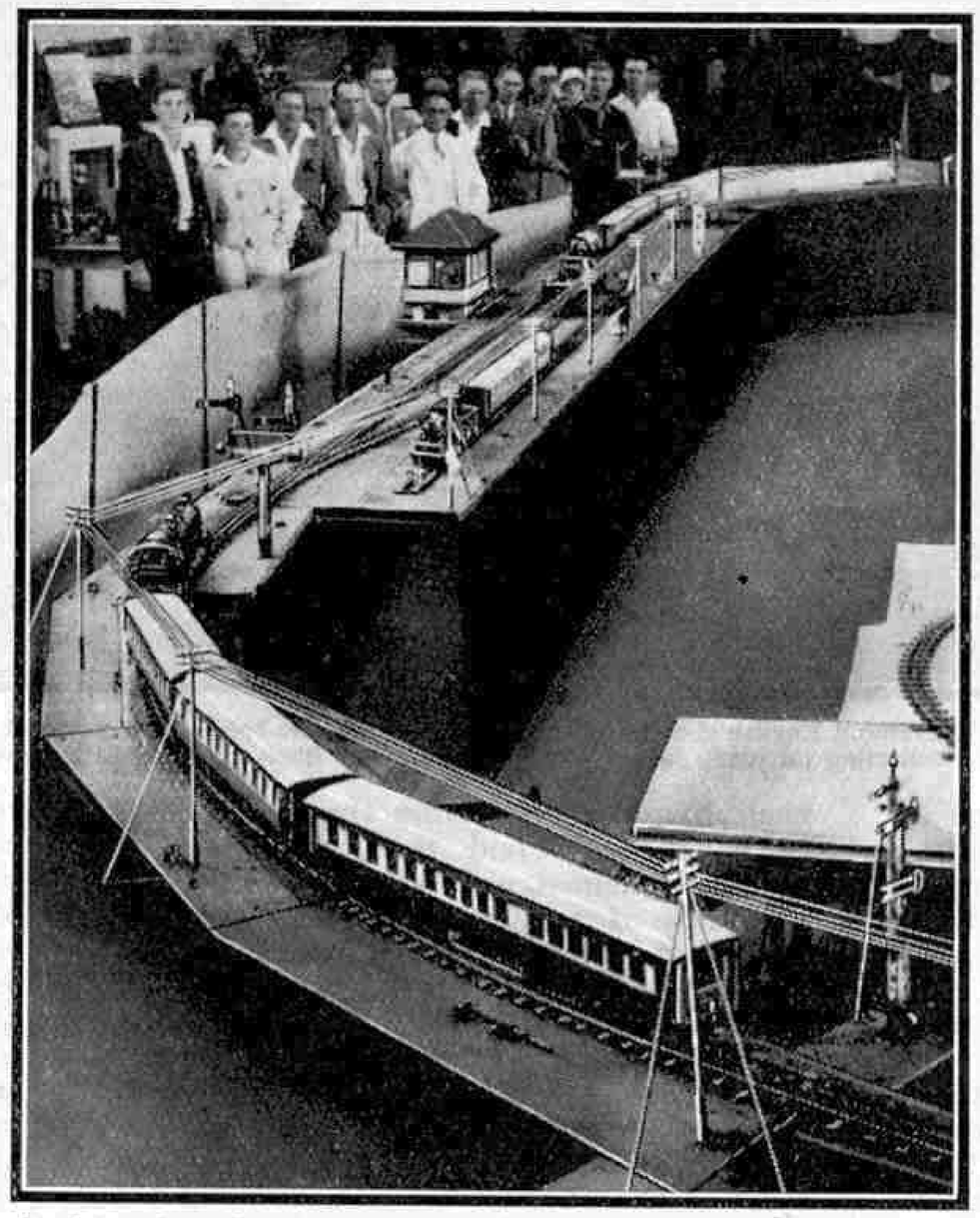
A very interesting public demonstration of the efficiency of track circuiting was given in Kimberley some time ago. Members of the public flocked to see an electrically-controlled model railway and yard layout planned and built by the Signal Inspector and his staff employed on the Cape Northern System of

the S.A.R. With only three months in which to prepare, these railway enthusiasts invoked the aid of the Chief Mechanical Engineer and the Chief Signal Engineer at the railway headquarters, Johannesburg. A promise of practical support was promptly forthcoming, and the track was built to a gauge of $1\frac{3}{4}$ in. in the form of an oval 53 ft. by 23 ft. The whole was built to scale and faithfully followed the regular S.A.R. standards, the yard incorporating all details, signals and points, and an electrically - interlocked lever frame and signal cabin. All lines between the home signals on the layout were track-circuited, the number of track circuits being five, operated by five relays loaned by the S.A.R. Administration.

A train of 21 special grain trucks on the South African Railways conveying a bulk consignment of maize. Photograph by courtesy of South African Railways and Harbours.

As in the regular practice on electrified portions of the S.A.R. lines, two running rails with a third conductor rail were used on the model layout. Current for the operation of the model trains was obtained through one rail, and the circuit for the return current was provided by another. The remaining rail of the three was used for the track circuit. Interference from the traction current was obviated by the use of high-resistance relays. Control of trains on the track was secured by means of dead sections at every signal, and current was switched on to the normally dead sections by the operation of the levers in the signal cabin. The passage of a train automatically disconnected the circuit and thus protected the line.

The beautifully constructed model signal cabin, which was greatly admired by all who saw it, was appropriately named "*Diamond Fields*," and the diagram used in the cabin indicated that the main line to stations on either side of the cabin ran from "Depression" to "Prosperity." The 20-lever frame was an exact reproduction of the original used by the railway authorities. The cabin was electrically illuminated, and contained a miniature framed diagram-indicator, operated by track circuits, as used in actual cabins. By means of this indicator the signalman could see at a glance which roads were occupied and the positions of the various signals, for diminutive electric lights showed on the diagram the "yard position" and the effects of various lever movements.



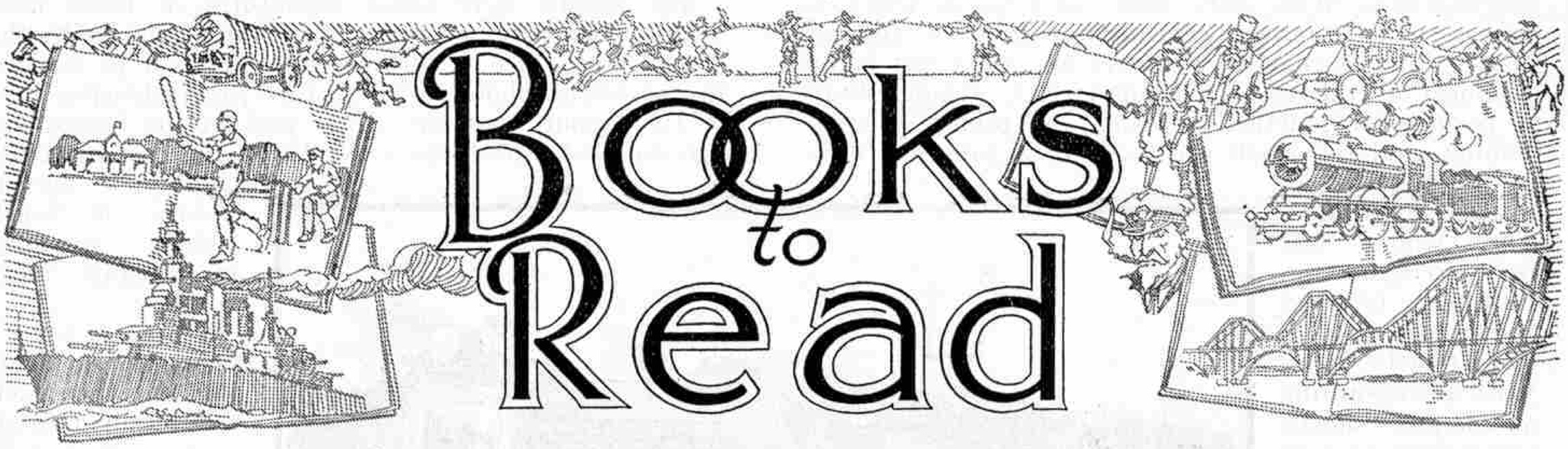
An interesting view of part of the miniature layout mentioned in this article, showing the yard and signal cabin.

The signals were exact miniatures of those used on the main lines of the S.A.R., conforming with the standard practice of the country. It will be noticed in the lower photograph on this page, showing part of the layout, that the signal post in the foreground accommodates both the outer home and distant semaphores, a special feature of South African practice, as already mentioned.

The model locomotives operated on the track were all super-detail models of S.A.R. steam locomotives built by Kimberley railwaymen. They were fitted with small motors concealed in their fireboxes, and were operated on current from a 12-volt battery. A model of locomotive No. 877, of the 4–6–2 "16 DA" class built by Henschel and Sohn of Kassel, Germany, was awarded a Championship Diploma and during the exhibition it covered approximately 50 miles on the model track, hauling as an average load four miniature S.A.R. saloons, built to a scale of $\frac{1}{2}$ in. to the foot. An illustration of No. 879, which is similar to the other Henschel "16 DA" locomotives except for being fitted with Caprotti poppet valves and gear, is shown on page 472. These "Pacifics" were built exclusively for express passenger work, and are employed on the fastest de luxe trains running between Capetown and Johannesburg, the "*Union Limited*" and the "*Union Express.*"

It was found that the model track was not sufficiently strong, and the 11 ft. 6 in. radius curves not quite adequate, to allow of the operation of a remarkable model, also built at Kimberley, of one of the giant "Garratt" 4–8–2 : 2–8–4 locomotives. Otherwise the track and the general operation of the model layout fulfilled all expectations.

Mr. Boulanger, the Signal Inspector for the Cape Northern System, who is stationed at Kimberley, has decided to build a new model layout with heavier rails and larger curves. It will be considerably more elaborate than the one exhibited and will include all types of signals in use on the South African Railways in all four provinces of the Union. Automatic and remote control signalling will be incorporated on the improved layout, so that its operation will be even more interesting than that of the line described here.



"The Book of Chemical Discovery"

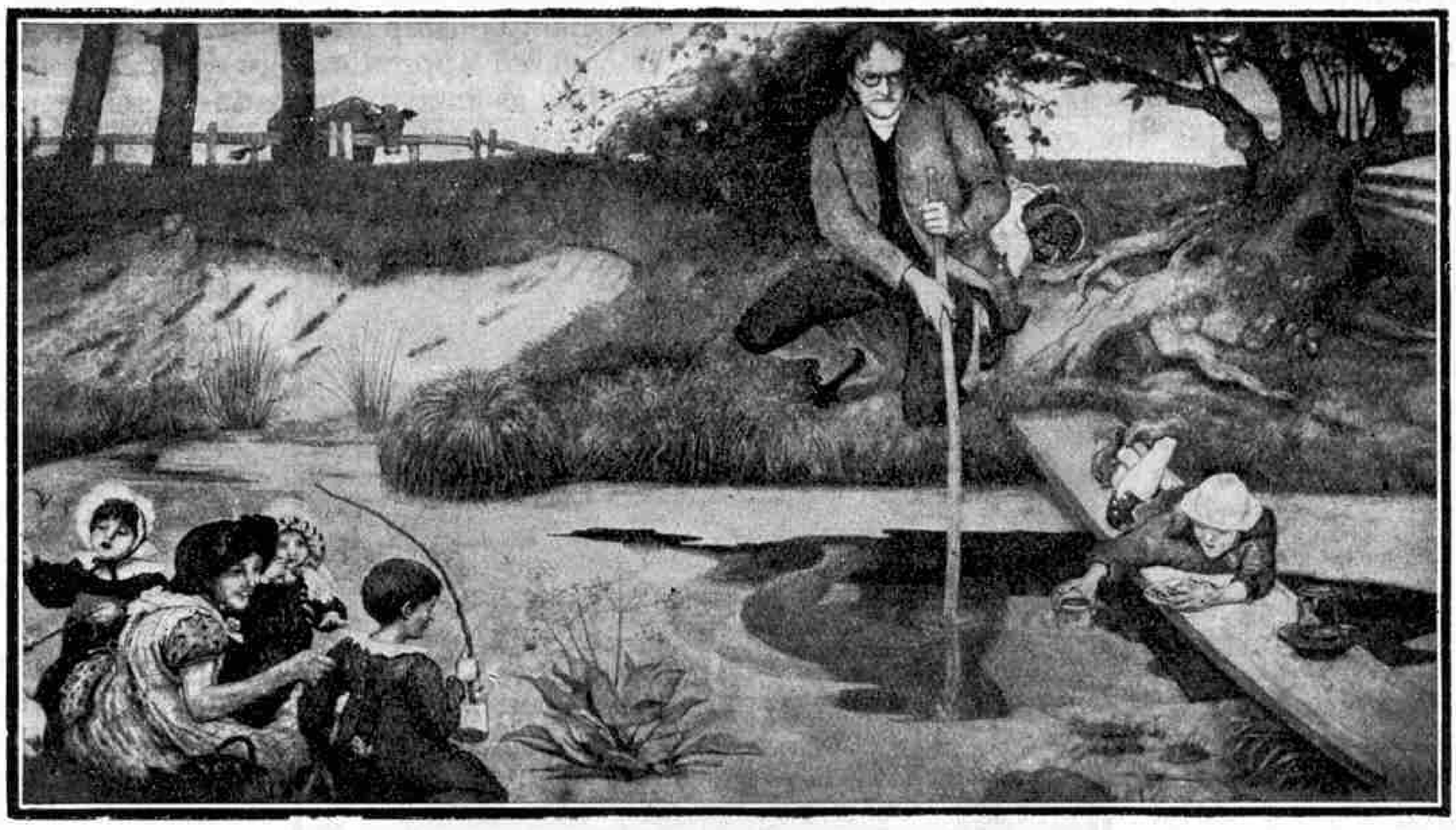
By LEONARD A. COLES, B.Sc., A.I.C. (Harrap. 7/6 net)

As all owners of Kemex Outfits are aware, chemistry is one of the most fascinating of all branches of science. It is not a dull school subject, but one full of romance, and the story of the revelation of its secrets by the great explorers of science is of never-ending interest. During the course of centuries countless men and women have spent their lifetime, and many have sacrificed their lives, in unravelling the mysteries of chemical science. Mr. Coles' book has been written to describe some of the most important chemical discoveries and how they were made, and to show the manner in which modern science has developed them.

The story begins at the time when fire was still an object of reverence and worship, and the author shows how its use led to the discovery of such metals as copper, tin, lead and iron, and to the making of pottery, glass, lime and other useful things. The art of dyeing also was introduced in very early times, and another chemical process that became important many centuries ago was fermentation, which not only brings about the transformation of grape juice into wine, but is involved also in the making of bread, the staple food of civilised Man.

As chemical knowledge grew, there appeared on the scene the alchemists, those mysterious figures who tried to make precious metals from baser materials such as lead and tin, and even to produce an elixir that would cure all ills and prolong life to hundreds or even thousands of years. All the efforts of the alchemists in these directions were fruitless, and unfortunately many of their ideas were made use of by rogues to swindle simple-minded people. In other directions, however, the alchemists did valuable work, and although in the end they disappeared, it was not before they had paved the way for more enlightened investigators, who were concerned with practical matters such as the discovery of new substances and the use of chemicals as medicines.

Chemistry now began to stride forward with greater confidence, and it made wonderful progress under the inspiration of Boyle, Priestley, Cavendish and Dalton in England, and Scheele, Lavoisier and others abroad. The period during which these men worked might almost be described as the heroic age of chemistry. Mr. Coles gives us interesting details of their lives; he describes the experiments in which they laid the foundations of modern chemistry, and concludes with accounts of such amazing modern discoveries as the electron and the proton, the incredibly tiny particles of which all chemicals are built up, and radium and other radio-active elements.



John Dalton (1766-1844), the famous English chemist, stirring up the mud at the bottom of a stagnant pool in order to cause bubbles of marsh gas to rise into a collecting jar ready for analysis. (From "The Book of Chemical Discovery," reviewed on this page.)

The next section of the book deals with laboratory work. It opens with a chapter in which some of the most highly valued tools of the chemist are discussed, and a comparison is made between the methods of the alchemists and those of to-day. The alchemist had to be content with a furnace burning coal, coke, or charcoal, with a bellows to aid him to attain higher temperatures. To-day the chemist lights his Bunsen burner, or makes use of his blow-pipe; or if he requires heating on a more extensive scale, he makes use of electric furnaces that enable him to attain temperatures never dreamed of by the alchemist. The modern chemist need not confine his investigations within the walls of his laboratory, for by means of the spectroscope he is enabled to extend his chemical analysis to even the most distant stars. This chapter is followed by sections in which the nature of chemical experiments is explained. The examples given, which include outstanding experiments of the great masters of the science, show how fascinating it is to track down undiscovered elements or to discover new compounds.

Finally the author deals with industrial chemistry, and shows how chemistry has penetrated into every corner of our daily life. He shows also that the romance of the science is by no means a thing of the past. He tells the stories of such modern marvels as the transmutation of wood into artificial silk, and the production from one and the same source of such widely-differing substances as brilliantly-coloured dyes, explosives, drugs and medicines, and road-making materials—all products of coal tar. It is no exaggeration to say that work of this kind has barely begun. As Mr. Coles remarks, "the well of chemistry is still far from dry." His book will have served its purpose if it inspires readers who are beginning their chemical studies to persevere in order to contribute their share to the further conquests that are in store for those who follow up discoveries already made and explore new branches of this great science.

The attractions of the book are increased by an ample selection of illustrations. These include 60 excellent drawings of typical laboratory apparatus, among them examples used by the great masters of the science; and 34 plates giving portraits of famous chemists or showing them at work, or illustrating important industrial applications of chemical processes.

"Amateur Pilot"

By THE EARL OF CARDIGAN (Putnam. 7/6 net)

In his introductory chapter Lord Cardigan expresses the hope that both the amateur pilot and the layman may find something helpful or interesting in this book. A dual purpose of this kind is excellent in theory, but is difficult to achieve, as is clearly shown in the earlier chapters. Lord Cardigan writes in a simple and interesting manner, but his material seems too complicated for readers who have never flown, and at the same time too elementary to be of value to those who have already taken lessons in flying. It is indeed doubtful whether the author's insistence on difficulties of various kinds is likely to encourage those who are wondering whether to take up flying or not. The later chapters, dealing with the author's own flights, including a trip to Prague, are of much greater interest, and the newly-fledged pilot will find much of value to him in the amusing accounts of the various incidents.

Lord Cardigan tells us that every aeroplane accident of which he has had personal knowledge has tended to shake his faith in pilots but to confirm his faith in aeroplanes. There is much to justify this faith, but it appears to have led Lord Cardigan to minimise the risks of flying in general. His rather light-hearted attitude towards the danger of forced landings will certainly not be shared by the majority of pilots of long experience.

In spite of its defects this book will be read with pleasure by all who are interested in flying.

"The World of To-morrow"

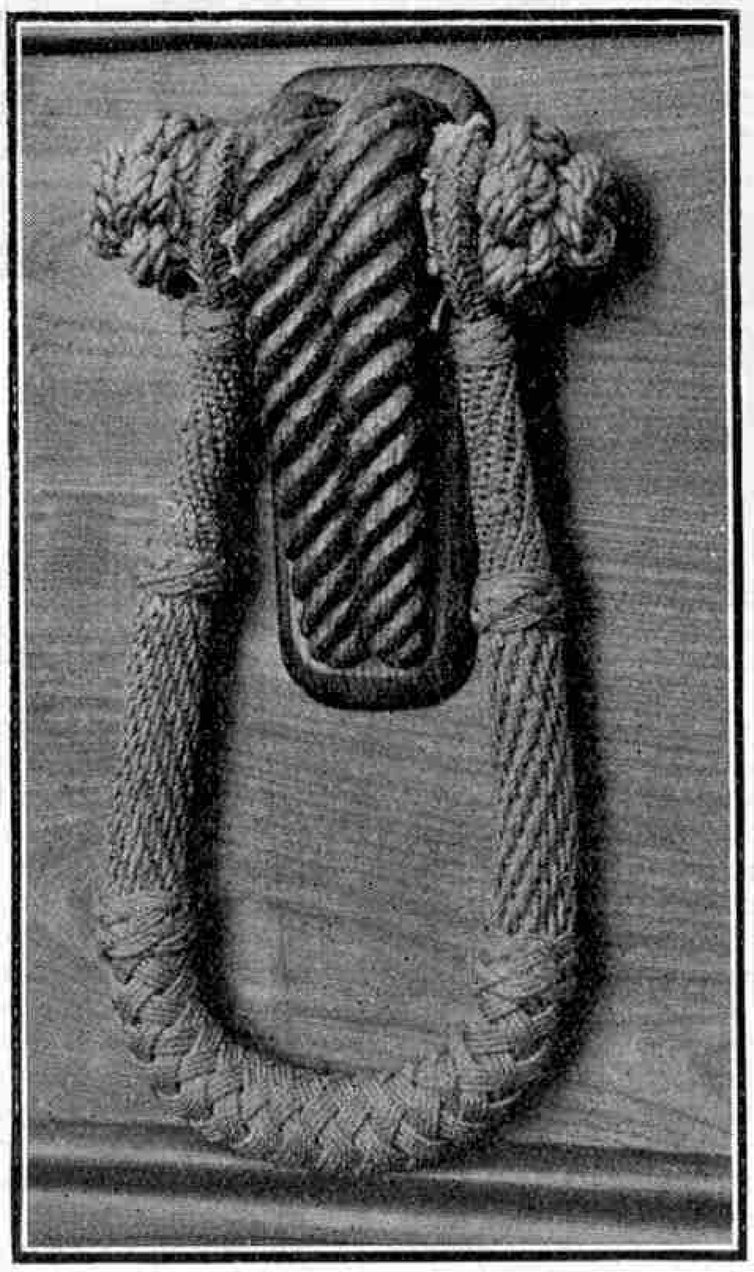
By I. O. EVANS (Denis Archer. 10/6 net)

Few things are more fascinating than speculating about the future and trying to imagine what the world will be like 100 years hence. In this book Mr. Evans attempts to forecast the changes that science and engineering will bring about in our daily lives. He shows how we may ultimately replace our diminishing stores of coal and oil by harnessing the Sun and the tides, and by making use of the internal heat of the Earth. In those days we shall travel by stream-lined electric trains with a speed of 120 m.p.h. or more, and by aeroplanes of new types, compared with which the aircraft of to-day are crude and cumbersome. We may even progress so far as to become masters of time and space. The author devotes a fascinating chapter to the possibilities of exploring the Moon, and possibly some of the planets, by means of space rockets and he gives an interesting account of the sensations of an explorer who ventures into space in such a rocket.

These wonderful developments will be accompanied by a revolution in our ideas of industry and government. The author pictures the people of the future living in splendidly planned cities giving free access to light and air, and taking advantage of all the discoveries of science to lighten the burdens of everyday life, so that the inhabitants will have far more leisure than is possible in our present-day world. Disease will be conquered, and the weather will be controlled so as to produce uniformly pleasant and healthy conditions.

It is appropriate that this peep into the future should appear in a form that strikes a new note in book production. The cover is made of a material named "Rhodoid," which is translucent, stainless and washable, and the edges are turned over to protect the pages from wear. The binding has been carried out by a method that is claimed to give greater permanency than stitching. Special attention has been given to the illustrations, and the 24 excellent plates that depict the author's conceptions of scenes in the world of the future are printed on a transparent material called "Diophane," instead of paper. The result is interesting, for the pictures become quite remarkably brilliant when the sheets of Diophane are pressed down on the white paper beneath them.

The wingless Autogiro, which may be the type of aircraft of the future. (From "Amateur Pilot," reviewed on this page.)



A handle or shackle for a sea chest. (From "Knots, Splices and Fancy Work," reviewed on this page.)

"Knots, Splices and Fancy Work"

By C. L. SPENCER

(Brown, Son & Ferguson Ltd. 5/– net)

The age of sail has left in its passing a number of fine and beautiful arts, some of which have been absorbed into our everyday life almost without our being aware of it. Many of them, however, like the ships that gave them birth, have been almost forgotten, and among these is the art of knotting and fancy rope work, which at the height of the sailing ship era had been brought to an amazing state of perfection. Since the coming of steam this art has declined, and except among the few surviving old-time shellbacks, fancy knotting has become almost extinct.

The author's object in writing this book has been to make an effort to preserve to some extent this fast dying art, and it is to be hoped that as the result of his efforts more attention will be paid by yachtsmen and others to the good rope work that is the sign of the real sailor, and less to scrubbing decks and polishing brasswork. The book contains over 200 examples of knots, splices and fancy work of various kinds, and much of the material has never previously appeared in print. The descriptions throughout are clear and easy to follow, and the illustrations, which number more than 260, are well drawn and excellent for their purpose.

"Roving in Four Continents"

By C. BRACKENBURY

(Brown, Son & Ferguson Ltd. 2/6 net)

The reminiscences of mining engineers are usually interesting, and this is certainly the case with those of Mr. Brackenbury. Commencing with his ranching days in the Rockies, the author describes his training for a mining engineer, and his subsequent experiences in a professional capacity in America, South Africa, and some of the wildest parts of Europe. His work took him continually off the beaten track, so that he got to know something of the real characteristics of the people of the various countries. Russia seems to have impressed him with its vastness, its barbarism, and its plotting and counter-plotting, giving him little confidence in either the people or the Government. Two chapters of the book are devoted to the Great War, in which the author served as an officer, mainly in an infantry Pioneer Battalion, but also for some time in a Tunnelling Company. Altogether, this is a very interesting and entertaining little book, and one hopes that the author will achieve his ambition of realising from its sale a sum of money to be handed over to the funds of the Boy Scouts Association.

List of Books Received

The undermentioned books, recently published, will be reviewed in a future issue.

ROMPING THROUGH PHYSICS
by Otto Willi Gail (Routledge, 4/6)

100,000 WHYS
by M. Ilin (Routledge, 3/6)

BLACK MIST
by Commander Gatti (Hutchinson & Co., 18/9)

EVERYBODY'S BOOK OF AEROPLANES
(Percival Marshall & Co., 1/6)

BRITISH AEROPLANES
by C. A. Sims (G. & C. Black Ltd., 3/6)

"Caerphilly Castle" in Miniature

The Boiler, Tender and Fittings

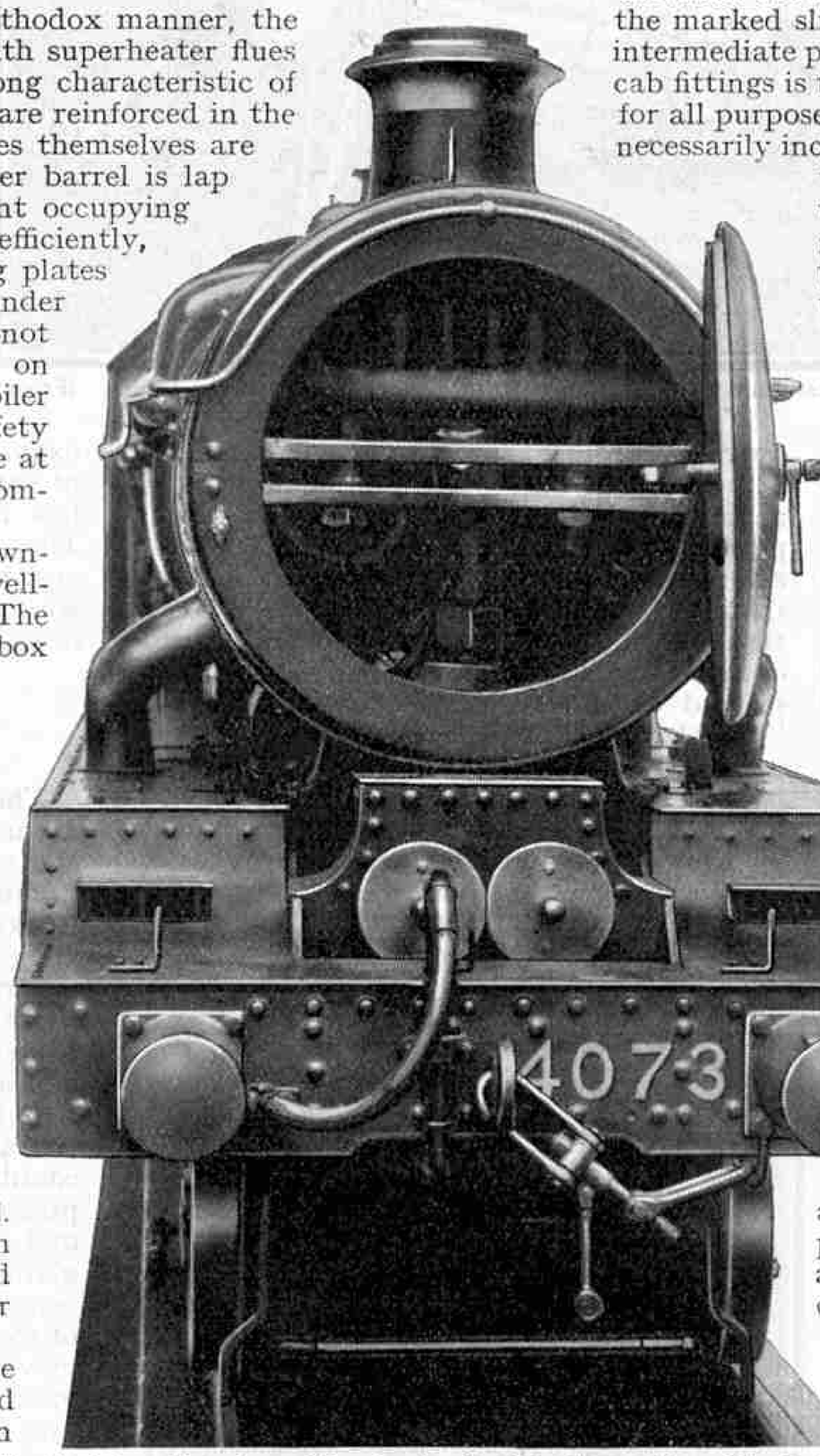
LAST month we gave a general description of the remarkable 1 in. scale model G.W.R. locomotive built by Mr. J. A. Nicholas, of Birkenhead, and dealt with the various details of the frames, cylinders, motion, and running gear generally. In this article we describe the boiler as a whole, the cab with its numerous fittings, and the tender, together with the different accessories provided on the complete engine.

The engine is coal fired in the orthodox manner, the boiler being of the fire-tube type with superheater flues and having the tapered barrel so long characteristic of Swindon practice. The tube plates are reinforced in the tube area, and the solid drawn tubes themselves are expanded and brazed in. The boiler barrel is lap jointed and double riveted, the joint occupying the bottom centre line. It is lagged efficiently, so that the outer casing or cleading plates remain comparatively cool when under steam, and the paint therefore does not suffer in the manner common on miniature locomotives. On the boiler barrel is mounted the familiar safety valve cover with the two humps, one at each side, that in real practice accommodate the top feed clack valves.

The fire-box slopes inward and downward towards the cab end in the well-known manner of the G.W.R. The sides and the crown of the inner fire-box are strongly stayed to the outer. Several stays also extend from the smoke-box tube-plate to the back-plate in the cab. The boiler and fire-box are of copper, and the various joints are securely riveted and brazed. The foundation ring is a sound brass casting, the inner and outer fire-box plates being riveted together through this. The efficiency of the boiler is such that it will evaporate about 2½ pints of water a minute, and working pressure is easily maintained. It has been found in practice that a pressure of between 60 and 80 lb. per sq. in. is all that is required to give a very satisfactory drawbar pull. During tests the boiler has been under steam at 150 lb. pressure, and was tested hydraulically at 250 lb. per sq. in. after construction.

An ash-pan is fitted below the grate bars, which rest on the usual slotted inside ledge. The grate is arranged in two parts, the forward part sloping downward and the after part being horizontal. The fire bars of each part of the grate resemble a nest of bars bolted together instead of each bar being separate. This construction was adopted because clinker forming round individual bars has an annoying habit of adhering to them and displacing them. The functions of the brick arch of the prototype in securing the efficient combustion of the fuel are carried out by a cast iron arch in the model. Such an arch lasts a long time, and can easily be replaced when wasted by another casting from the same pattern, whereas a miniature brick arch would be difficult to reproduce and maintain.

The smoke-box is of the circular drumhead type favoured at Swindon. Owing to its special construction, and the provision of lagging in between the two thicknesses of metal forming the inner and outer casings respectively, the smoke-box remains only warm to the touch when the engine is working. It contains the superheater headers, steam pipes, blast pipe, blower or steam jet, and the brake ejector discharge pipe. The chimney has the usual G.W.R. downward extension inside the smoke-box, known as the petticoat or lift pipe, and the smoke-box door is firmly fastened, as is necessary in a coal-fired locomotive, by means of dart and crossbar fittings as in actual practice.



An interesting view of the front end of the locomotive. The inside of the smoke-box can be seen, and the vacuum pipe and screw coupling are prominent on the front buffer beam.

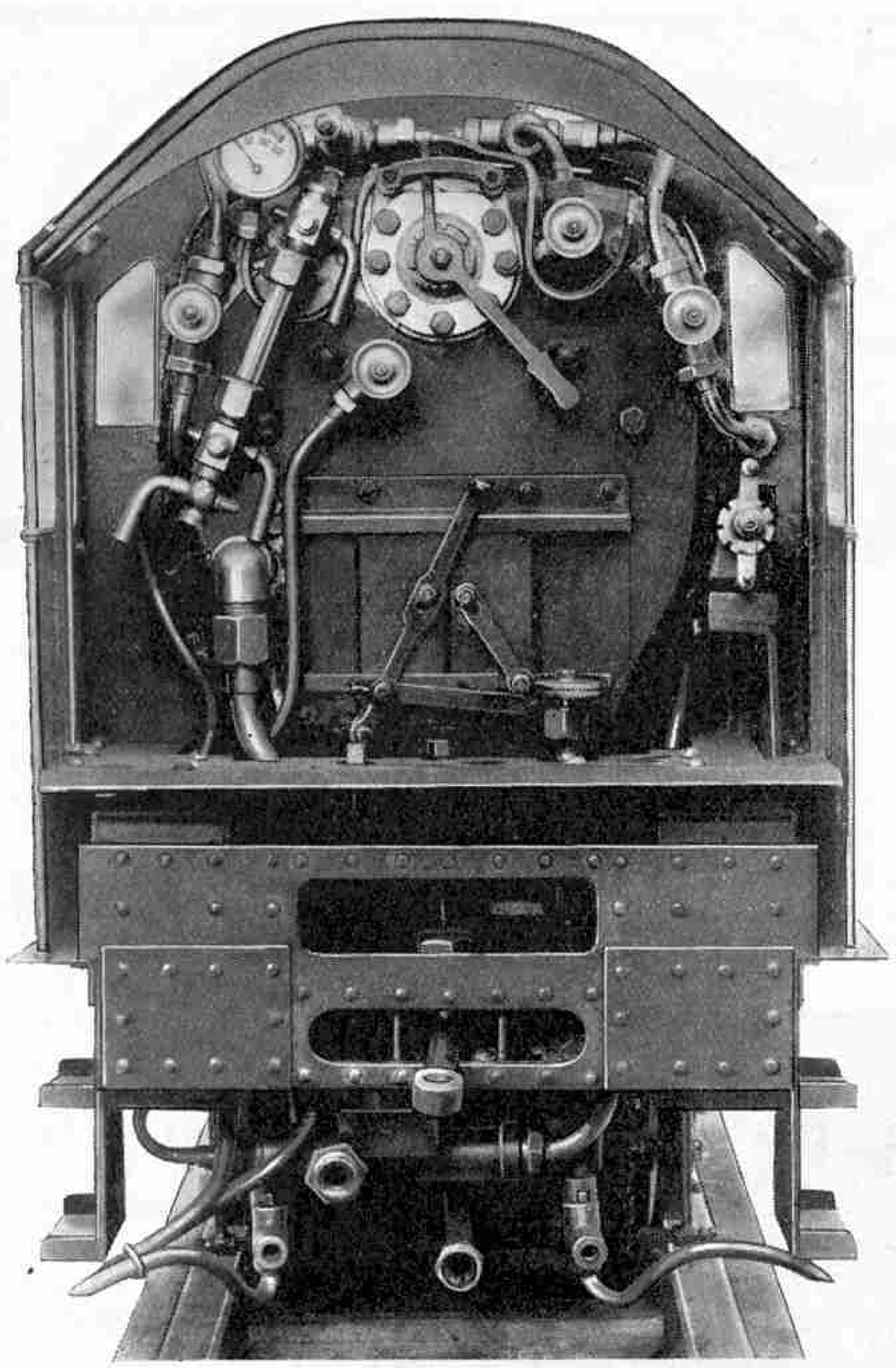
The cab is very fully fitted up, and the lower photograph on the next page gives a very good impression of this part. The typical regulator handle and reversing screw are shown, the latter enabling very fine manipulation of the engine to be obtained. A metal block traverses the screw as the handle is revolved, and indicates on the marked slides full fore and back gear, mid gear, and the intermediate points of cut off. An interesting point about the cab fittings is that wheel valves instead of plug cocks are used for all purposes except the water gauge. The latter fitting is necessarily inclined owing to limits of space, and is provided with two cocks to enable it to be shut off quickly from the boiler if necessary. There is also a gauge blow-down cock to enable a clear reading to be obtained. The pressure gauge is of the usual Bourdon pattern, and reads up to 150 lb. per sq. in. This gauge was obtained from Bassett-Lowke Ltd., of Northampton. Provision is also made for the fitting of another gauge on the opposite side of the cab, in order to check the accuracy of the first gauge periodically.

The fire-hole is provided with two sliding doors of G.W.R. pattern, both opening or closing simultaneously by the manipulation of a single lever. The cab windows, which are beaded with polished brass, are glazed with mica, and the roof is removable for inspection of the fittings and for convenience in operation.

The engine is provided with fully-working vacuum brakes, and a large ejector is situated in the correct position on the side of the fire-box casing outside the cab. Its exhaust pipe rests in typical G.W.R. brackets spaced at correct intervals, entering the smoke-box with a short elbow bracket casting. Steam is admitted to it by means of the wheel valve shown on the driver's side over the reversing screw. It is interesting to note that, whereas in the actual ejector a four-coned nozzle is fitted, in the model a plain stub end proved to be the most effective arrangement. When steam is turned on in the cab a vacuum is produced in the cone-shaped ejector body. A ball valve fitted near the back end of the ejector is lifted, and air is drawn out of the train pipe.

Two brake cylinders are fitted to the engine, one situated between the main frames operating the brake blocks of the driving wheels through the usual pull rods and cross stretchers. Compensating links ensure even pressure on each block, and the adjusting gear on the original to maintain the blocks in alignment is reproduced in the model, and also the special fittings preventing the brake block pins from working out and getting lost. The whole of the brake apparatus, in fact, closely reproduces the original. The main vacuum brake cylinder pivots in its bearings according to the movement of the main brake lever to which it is connected. The standard type of rolling rubber ring is employed on the brake piston.

The bogie is brake-fitted, and is provided with its own brake cylinder. This is connected to the main train pipe by means of a flexible pipe coupling. The cylinder body rests on slotted side bearers, on which it is free to move, the brake rigging being divided into two sets, one coupled to the piston and the other to the cylinder. By this means both units automatically take up position according to wear on the blocks and the state of their adjustment. Hose connections are provided at each end of the engine and tender, the ends of the hoses being supported on "dollies" or



The cab and its fittings. The regulator handle and reversing screw exactly reproduce G.W.R. practice ; and the two firehole doors, operated by a single lever, are strikingly realistic. The large injector can be seen below the drawbar, and the two smaller dummy injectors appear on each side of it.

plugs at exactly the " Swindon angle," as on a real G.W.R. engine.

Water is fed to the boiler by means of a large injector, which is under the cab out of sight. From this it passes direct into a combined clack valve, the lift of which is controlled and adjusted from the cab. From the back of the clack box casting two pipes radiate, and are carried as in actual practice to humps on either side of the safety valve casing previously mentioned. The two small-scale injectors seen under each side of the cab actually form overflows to the main injector. Owing to their small proportions they would be incapable of coping with the volume of water demanded by the boiler.

There is in addition a blow-down valve to empty the boiler, which is fitted at the lowest point immediately above the fire-box foundation ring.

In addition to all these details, dummy sandboxes, sandpipes and operating rods are provided. Miniature lubricators are also a feature, and even such inconspicuous items as the little trapdoors in the footplating that allow of access from above to the connection between the rocking levers and the outside valve spindles.

The tender represents the large 4,000-gallon vehicle developed during the past few years at Swindon, and first fitted to No. 5000 "*Launceston Castle.*" Its six wheels carry the weight through axle boxes and laminated springs in the correct manner. The frames are of steel, but the body is built up of sheet brass to form the tank for water and to provide space for the fuel above this. In the tank is a large hand pump, useful for filling the boiler and in restoring the water level if it should have been allowed to drop rather low when working. The base of the pump is heavily flanged, and bolted to the tender bottom, giving strength and rigidity for the operation of the pump by means of its long detachable handle. There is also a movable plug provided in the pump uptake, to which any compressed air system can readily be attached in order to move the locomotive for demonstration purposes.

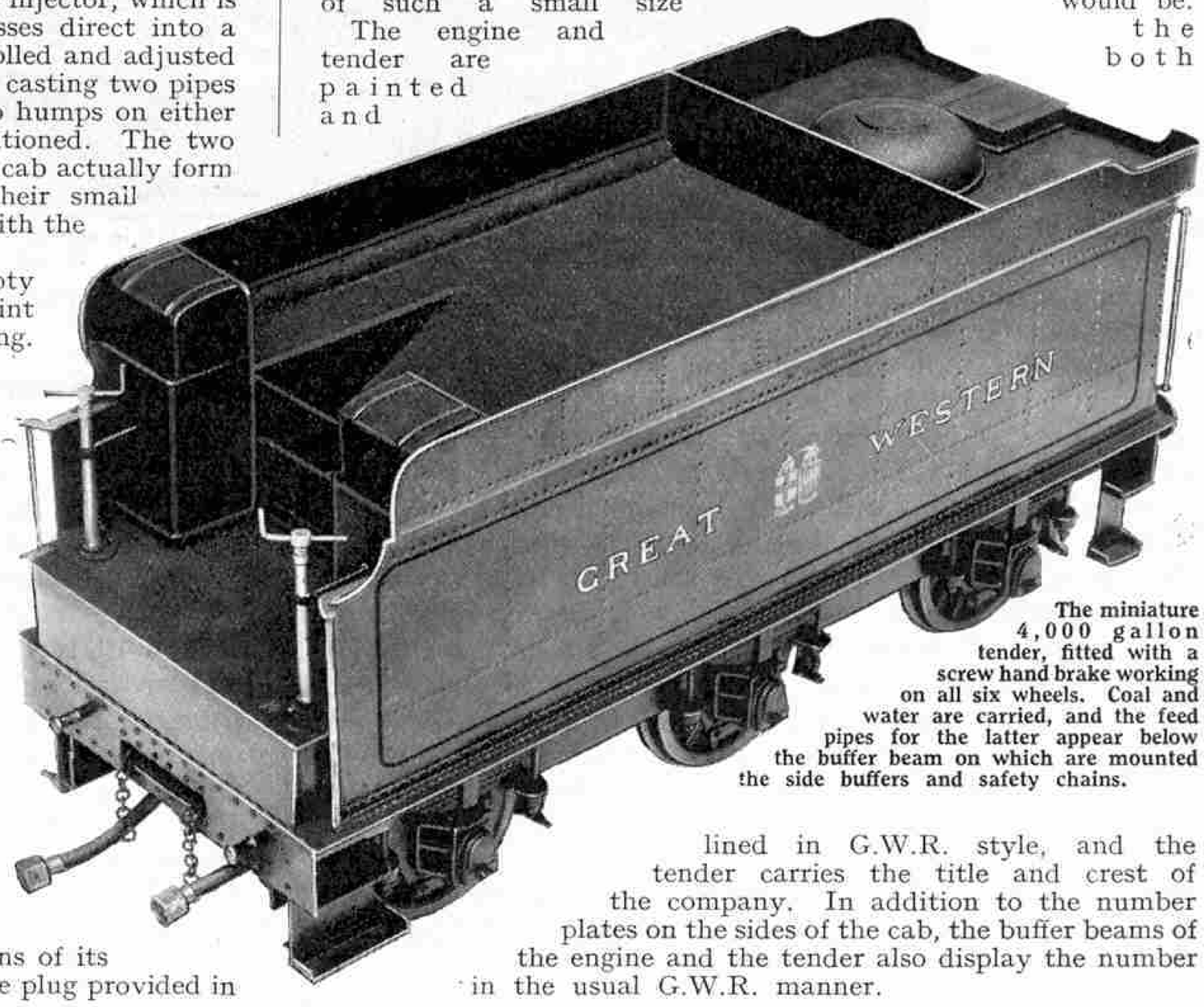
Pipe connections are led from the tender to the injector under the cab, and water is admitted to the latter by means of a simple throw-over valve on the tender tank mounted integrally with the force pump uptake. The necessary flexibility to allow for the relative movement of the engine and tender is given by arranging coils in the piping under the tank. The top of the tank is arranged to slope downward towards the front after the usual manner of self-trimming tenders. The coal "gate," where the fireman in real practice obtains his fuel, is closed in the correct manner by means of two detachable wooden strips, which represent the pine boards used in the original G.W.R. tender. The top of the tank behind the rear division plate lifts off for convenience in filling, and to allow of access to the hand pump. It is fitted with a dummy filler or manhole, and with the large G.W.R. water pick-up dome.

The two dummy tool boxes are very neatly made, as also are the brake and the water scoop handles. That on the left-hand side actually works the tender hand brake, which is quite powerful in action. Although a miniature water scoop is fitted below the tender, it is not a working accessory, for obvious reasons, and therefore is not connected to the other handle on the right-hand side. The engine and tender are coupled together in the proper manner by a drawbar, and there are in addition small safety chains that are shown in the tender photograph. Oscillation between engine and tender is restricted by the small side buffers or plungers shown on the front buffer beam of the tender, which work on buffing plates arranged below the footplate of the locomotive.

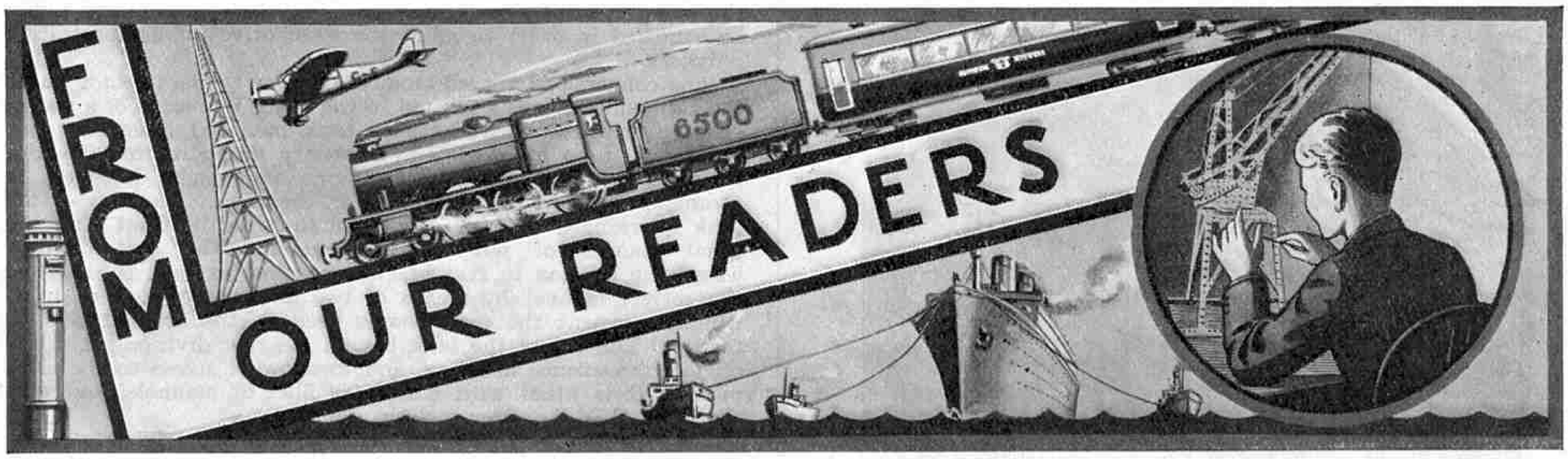
Both engine and tender are provided with spring buffers of the correct pattern, the buffer stocks being conical, but having a square flange for attachment to the buffer beams. Correct locomotive type screw couplings are fitted to the draw hooks, and they can be slung up when not in use in the well-known G.W.R. style, as shown in the head-on view of the engine. An item of interest is that where rivet heads—which are such a prominent G.W.R. feature—show in the real engine and tender, these are represented in the model by actual rivet heads, as in the buffer beams, or are embossed, as on the cab and tender sides, the splashers and the footplates themselves.

Steps, lamp brackets, handrails, and similar details are all provided, and the name and number of the engine appear on correct plates. These plates were built up by cutting the figures and letters out of thin brass sheet and soldering them in the correct position on to plates prepared to the correct size and outline, a beading of brass being run round the complete plate to represent the edge of the original. The effect is very fine, and the complete plates are much neater and clearer than ordinary cast plates of such a small size would be.

The engine and tender are both painted and lined in G.W.R. style, and the tender carries the title and crest of the company. In addition to the number plates on the sides of the cab, the buffer beams of the engine and the tender also display the number in the usual G.W.R. manner.



The miniature 4,000 gallon tender, fitted with a screw hand brake working on all six wheels. Coal and water are carried, and the feed pipes for the latter appear below the buffer beam on which are mounted the side buffers and safety chains.



These pages are reserved for articles from our readers. Contributions not exceeding 500 words in length are invited on any subject of general interest. These should be written neatly on one side of the paper only, and they may be accompanied by photographs, or sketches for use as illustrations. Articles that are published will be paid for at our usual rates. Statements contained in articles submitted for these pages are accepted as being sent in good faith, but the Editor takes no responsibility for their accuracy.

A Trout Farm

The accompanying illustration shows a scene on a trout farm, or hatchery, where trout are bred and reared until they are large enough for use in stocking fishing waters. A good natural water supply is the chief requirement for a farm of this kind, and from the hatching of the eggs to their departure the fish are carefully fed and tended.

Eggs to be hatched are placed in a shallow trough through which a continual flow of water passes. In due course the shell breaks, and the small fish, or "alevin" as it is called, begins to emerge tail first. Gradually the shell breaks right away and the fish is clear, and lies panting on the bottom of the trough.

Sorting out the young fish in one of the ponds of a trout farm. All fish in any one pool must be of the same size in order to prevent small fish from being eaten by larger companions. Photograph by J. Hutter, London.

The alevin soon pack themselves in a mass at one end of the vessel in which they are hatched. At this stage they require little attention and no feeding, for all the food they need is contained in a small bag attached to them, and their mouths are not properly formed until this food has been absorbed. When this takes place the alevin are ready to be transferred to a rearing pond, and now they require feeding. There are often accessory ponds in which small crustaceans are cultivated for the benefit of the young fish, who in addition are given minute quantities of artificial food consisting of very finely chopped liver, shrimp paste, and similar ingredients. Later they are fed on meat, biscuit meal and cockles. As they grow larger they are transferred to other ponds, and care is taken that only fish of the same size are in any one pool, for if they were mixed the larger fish would eat their smaller companions!

Trout are usually sold by the inch, but are sometimes sold by weight, when it can be assumed that they are going to a restaurant to supply the needs of those who prefer to choose their fish alive before it is cooked. The greater number are reared for re-stocking fishing waters, however, and every year millions of trout are bred to provide sport for anglers. They are conveyed from the hatchery in tanks containing water that is supplied automatically with oxygen from cylinders, and are then carefully transferred to the streams in which they enjoy the freedom of wild life until they are lured into snapping once too often at the artificial flies that are patiently dangled before them by skilful fishermen.

J. HUTTER (London).

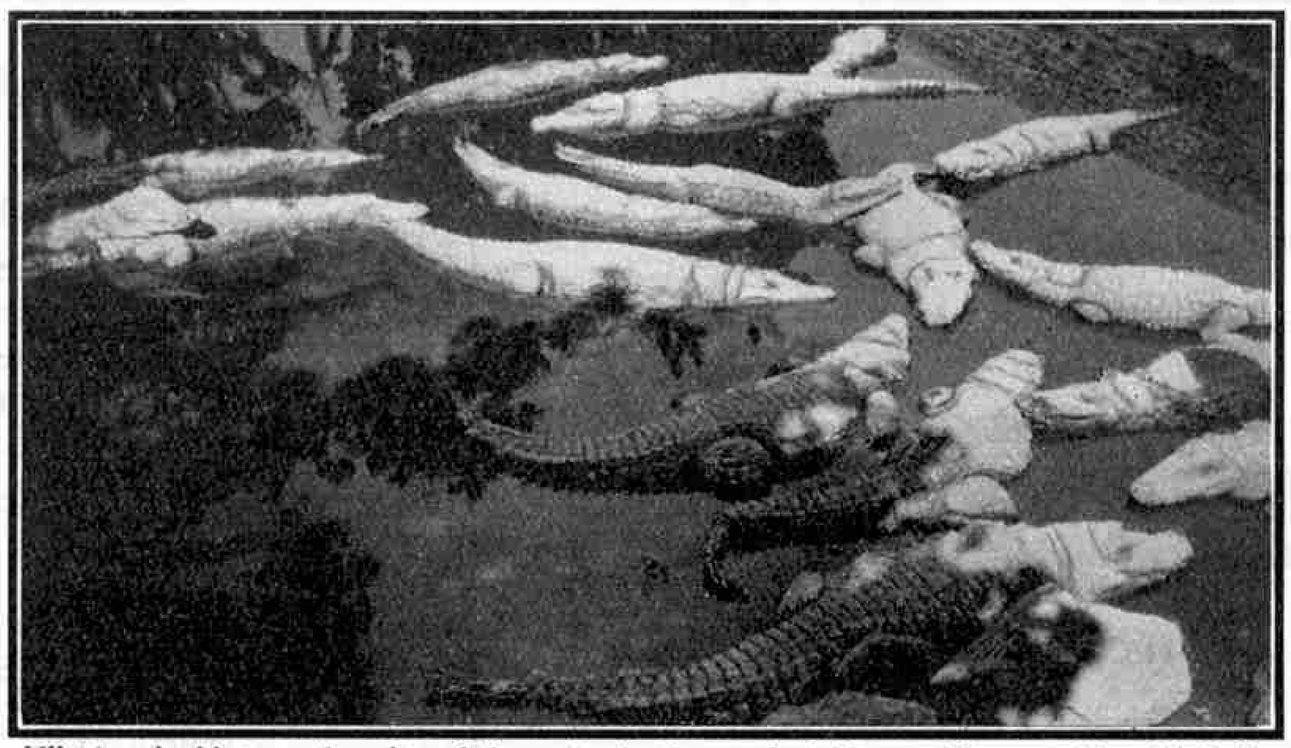
A South African Railway Centre

De Doorns in the Western Province of South Africa is an important railway centre at the foot of the Hex River Pass, where trains from Capetown to the Transvaal or Rhodesia begin in earnest their climb to the central plateau of South Africa. From Capetown to De Doorns, a distance of 129 miles by rail, there are gradients as steep as 1 in 40, but these are over short distances and usually one engine suffices for the average train. Only very short trains can ascend the Pass beyond De Doorns with only one engine, however, and most are either double-headed or have a banking engine coupled on at the rear. The "*Union Limited*" stops at De Doorns to take in water and to have a pilot engine, usually of the "Mallet" articulated type, coupled to its 4–8–2 locomotive. Other mail trains are longer and are therefore usually banked.

E. KILPERT (Somerset Strand).

The Alligator Pond of Mugger Pir

Visitors to Karachi do not fail to see its famous alligator pond. This is 10 miles away, at a place called Mugger Pir because of its association with these creatures, for mugger is the local name for the alligator. The site is in a basin between two ranges of hills, and is a pleasant oasis in a barren hilly tract where rainfall is scanty and vegetation rare. Hot and cold water springs rise from the ground, and the waters of these are famous for their medicinal qualities. The place seems to have been inhabited from remote times, for it is claimed that certain structures shown to travellers are more than 2,000 years old.



Alligators basking on the edge of the water in the pond at Mugger Pir, near Karachi, India. Photograph by M. P. Ghandi, Karachi.

How the alligators came to be confined in this inland spot is a matter for speculation, for there is now insufficient water in the spring to form even a rivulet, and there are no alligators nearer than the waters of the Hub River, which is 10 miles away. In the past the springs of Mugger Pir may have been connected with the river.

In order to prevent the possibility of harm to sight-seers, the main pond at Mugger Pir has been walled in so that the alligators are confined to it instead of being allowed to swim about the inter-connecting ponds as they please. In 1839 an English traveller counted at least 200 of the creatures in a single pond, but to-day their number is certainly not more than 60.

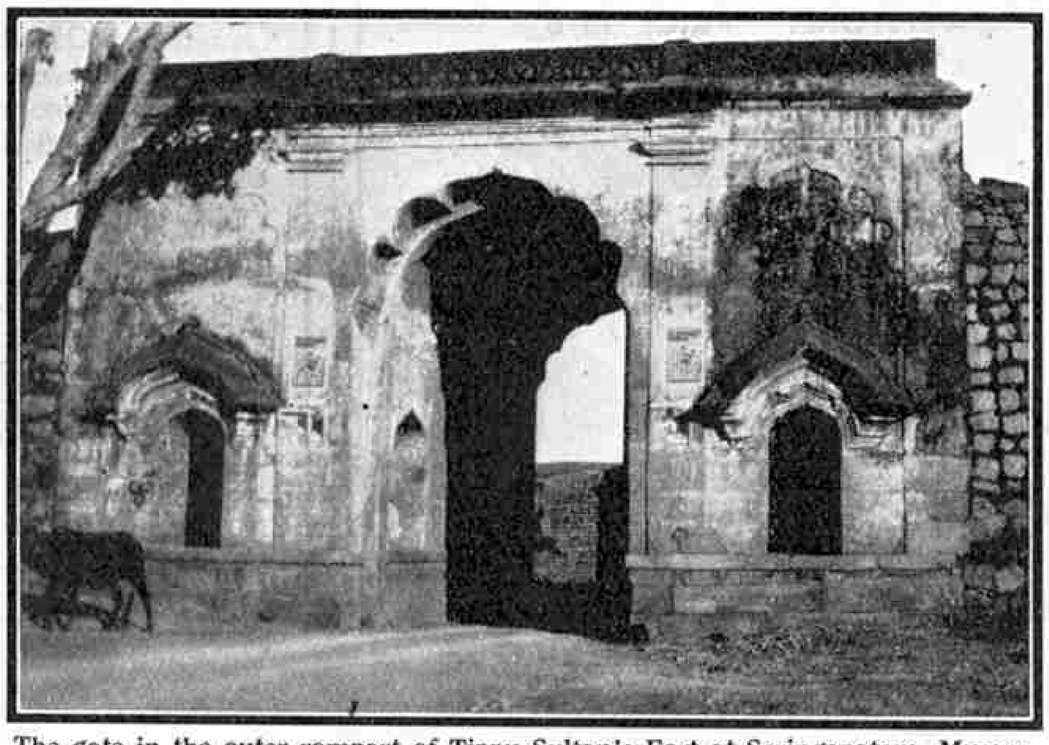
As they are crowded together in a pond not more than 100 sq. yds. in area, the monsters can scarcely support themselves, and they are fed with goats and lambs killed and offered to them as sacrifices. Ordinarily they lie despondently in the evil-smelling water, but they spring up with surprising agility when meat is about to be offered to them, and the sudden spurt of activity causes the keenest interest among visitors, and even among those who live near the pond.

M. P. Ghandi (Karachi).

The Dungeons of Tippu Sultan

The morning sun was shining with a clear brilliance over the plains of India when we decided to visit the far-famed island-fortress of Seringapatam, once the capital of Mysore. After half an hour's run by car we saw the white brilliancy of the towering minarets of the Great Mosque, built about 150 years ago by Tippu Sultan, the Tiger of Mysore ; and in a few minutes more we were entering the old fortress by the impregnable Mysore Gate, a wonder of the ancient military world. It was evidently a series of gates, only three of which now remain, leading through the massive stone outer ramparts and the scattered remains of what was once an inner rampart of mud and bricks.

As we entered, a chattering little youngster, who seemed to have the history of his native town on the tip of his tongue, sprang from a little recess in the mouldering rampart and offered to guide us to the parts most worthy of our interest. Under his magic touch the walls again became re-peopled with the surging hordes of Tippu Sultan's army. We mounted the crumbling walls and gazed at the great breach through which stormed the British troops who captured the city on 4th May, 1799, when the power of Tippu Sultan was completely destroyed.



The gate in the outer rampart of Tippu Sultan's Fort at Seringapatam, Mysore. Photograph by F. C. McIver, Watford.

A little farther on our agile conductor sprang down the rampart and suddenly disappeared, and a few moments later we heard his voice eerily circling upward, apparently from the depths of the earth. He had descended a flight of stone steps, and we followed him to the foot of a narrow ditch where about a dozen small stone doorways opened on our left. There was a faint odour of damp and rotting earth, and as we entered the mud squelched beneath our feet, and slimy, hissing forms glided away into the darkness, while above myriads of spiders scurried over the roof. These were the dungeons in which British soldiers captured by Tippu Sultan in the long wars that preceded his overthrow endured years of imprisonment. Beyond the ramparts were palaces, mosques, temples and imposing mausoleums, but to me these were far less impressive than the great breach in the walls of the city and the horrible dungeons under the ramparts.

F. C. McIver (Watford).

Stromboli in Eruption

During a voyage to Constanza in the Black Sea, the vessel in which I was travelling passed by the Lipari Islands, which are off the north coast of Sicily. The peak of the famous volcano Stromboli, 3,038 ft. in height, was the first prominent feature of these islands that we saw. It was sighted one Sunday about noon, and I noticed that over it there was a haze, which I learned was formed by the condensation of steam and vapour rising from lava on its slopes.

We were close to Stromboli when night came on, and streaks of flame could then be seen at the crater. As the darkness became more intense the volcano afforded a wonderful sight. From time to time the red streaks merged into a giant sheet of flame that leaped into the air and then suddenly disappeared, leaving an immense rising volume of smoke.

E. Evans (Mardy).

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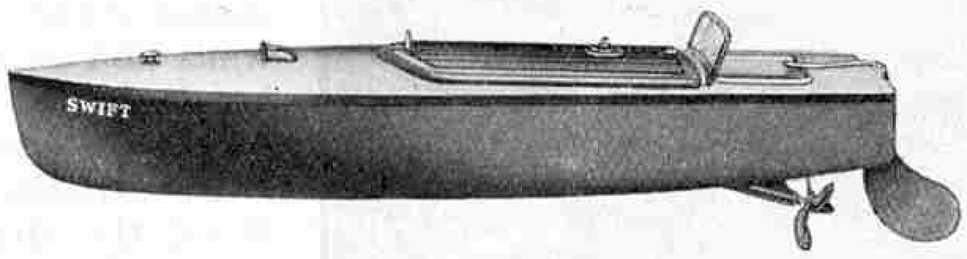

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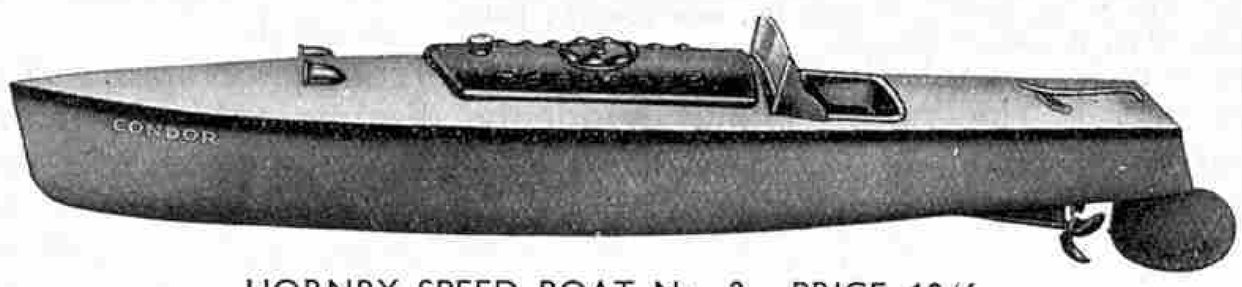

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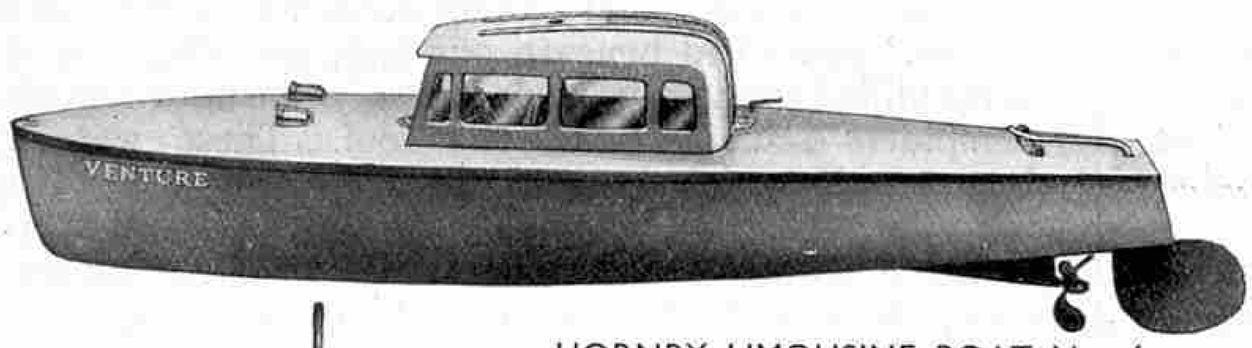

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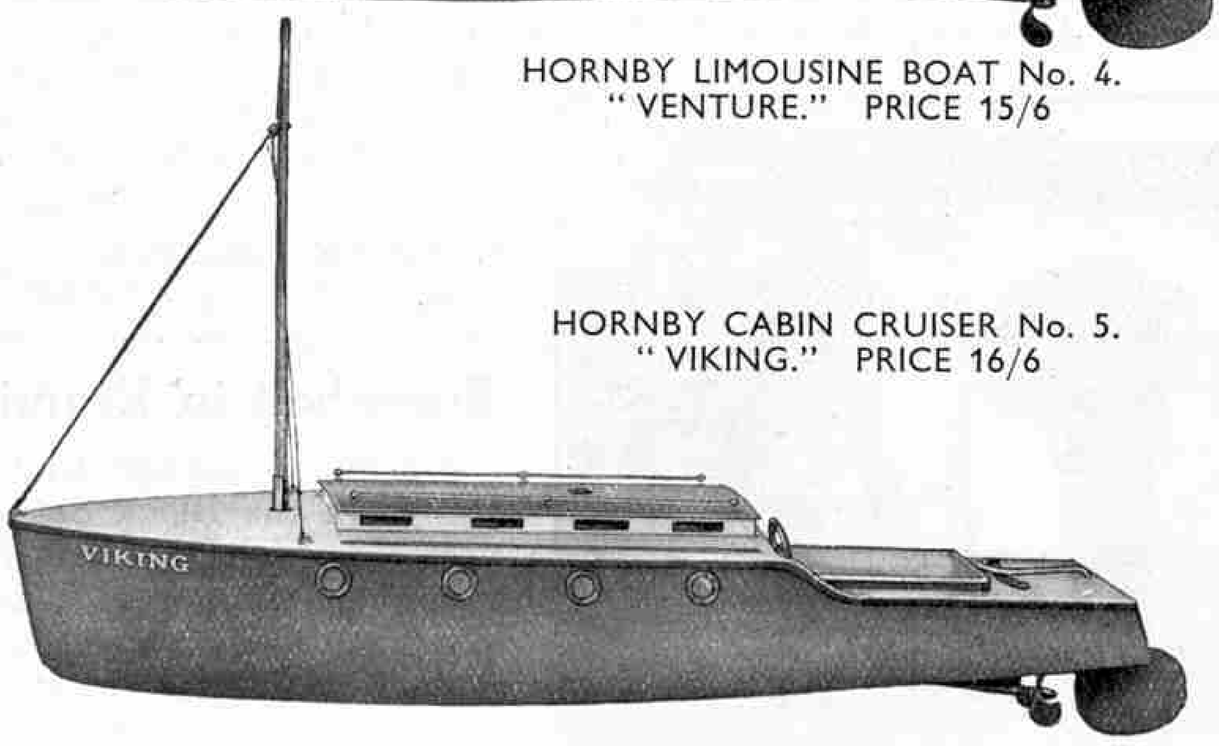

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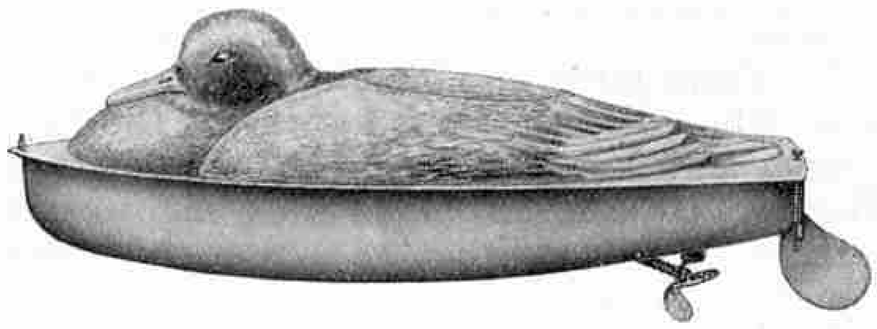

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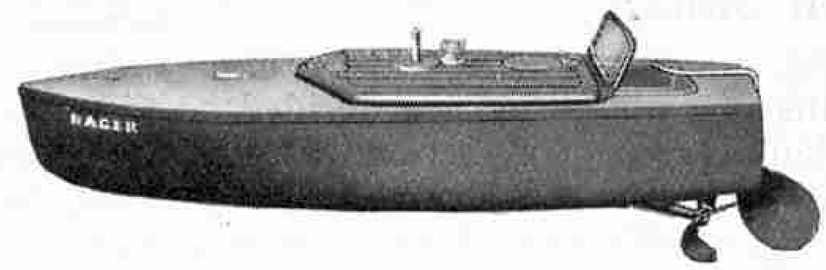

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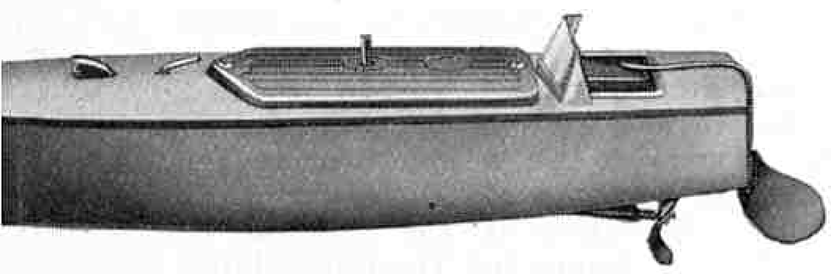

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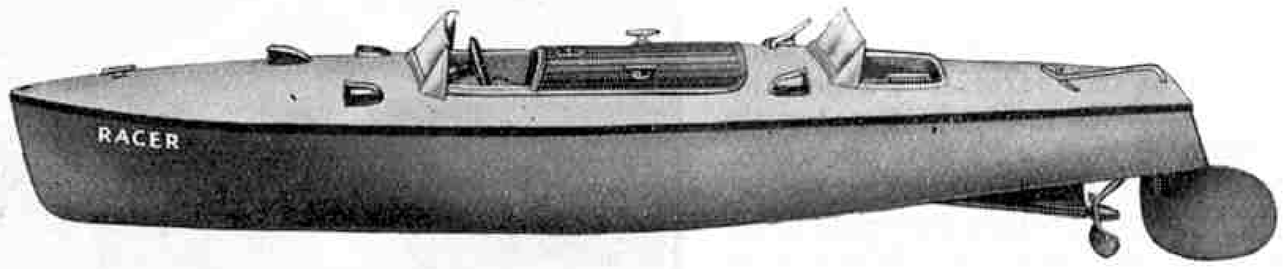

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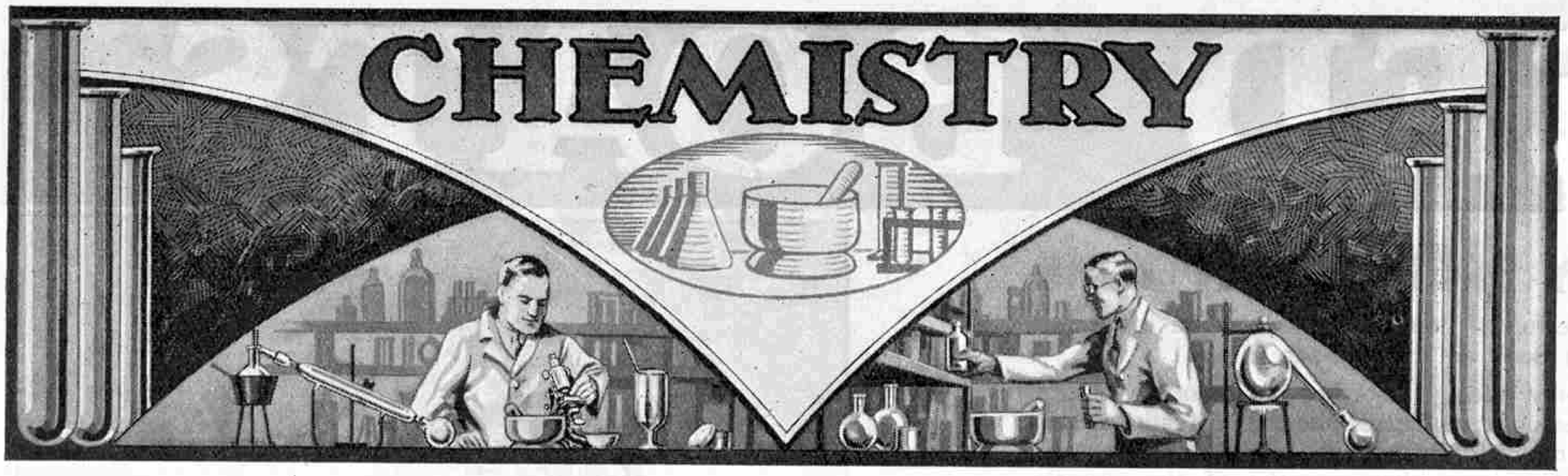


CHEMISTRY APPLIED TO SHIP REPAIRING

RECENTLY a ship-repairing operation of more than usual interest was carried out at Liverpool, the vessel concerned being the "*Lafian*," of the United African Company Ltd. When this was examined in dry dock the stern-frame was found to be fractured below the propeller boss, and just on the aft side of the line of rivets by means of which it was united to the keel plate. The vessel was urgently required for service, and therefore it was decided to effect the repair by the Thermit welding process, which involves a very interesting chemical action. This process had been used in America for similar repairs, but in this country had previously been almost entirely confined to welding tramway rails.

Thermit is the technical name of a mixture of powdered aluminium and iron oxide. When this is ignited by means of magnesium powder or a similar flash mixture, chemical action spreads at astonishing speed throughout the whole mass, and its temperature rises as high as 3,000 deg. C., or 5,400 deg. F. What actually happens is that the aluminium seizes upon the oxygen of the iron oxide, and thus the iron is set free. Owing to the high temperature developed, this metal is liberated in a molten state at the bottom of the crucible or vessel in which the mixture is ignited, and can be tapped off to provide the material required to effect welding.

In preparing the stern-frame of the "*Lafian*" for welding by means of Thermit, it was cut along the line of the fracture by means of an oxy-acetylene torch, and as the break appeared to run into a neighbouring rivet hole, a branch was burned to include the part affected. A gap of 1 in. was then left between the two sections, and this distance was increased by $\frac{1}{8}$ in. by shoring the sections farther apart in order to allow for contraction as the metal cooled after welding.

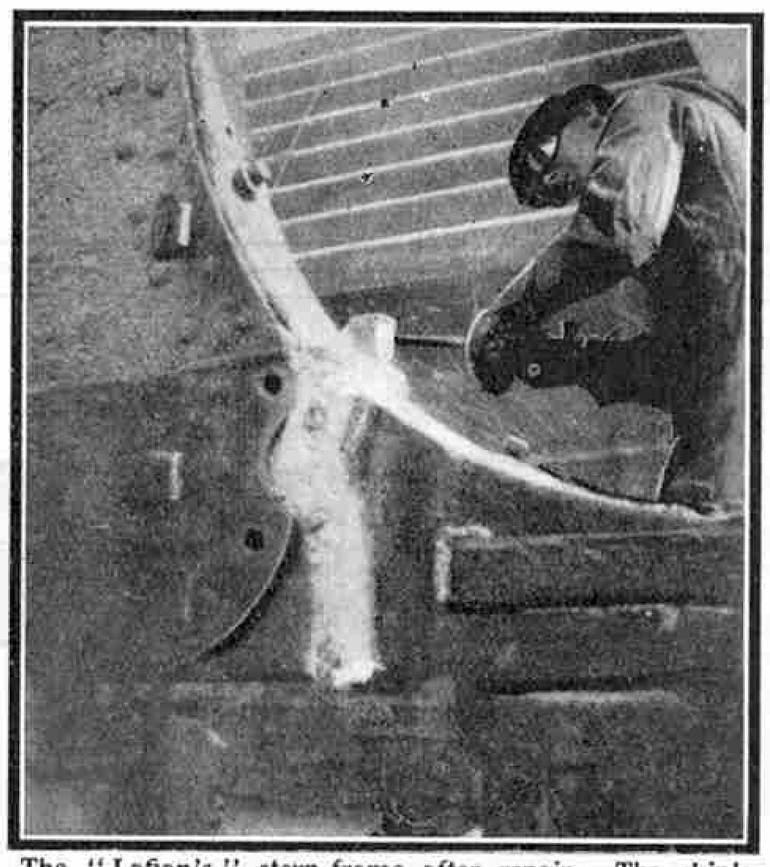
The stern-frame now presented the appearance shown in the upper illustration on this page, and the task of the welder was to unite the two parts by filling the gap between them with metal. A mould for the material to be added had first to be built up. The space cut away by means of the burner therefore was filled with a special wax that occupied the position intended for the metal; and this was given a thickness in excess of that of the stern-frame, because the metal to be deposited would have a tensile strength of 25 tons per sq. in., whereas the material of which the stern-frame itself was made had a tensile strength of from 26 tons to 32 tons per sq. in. A box constructed of steel plates bolted together was next built round the areas to be dealt with, including the wax filling, and special silica sand was rammed into the space left within it. This sand shaped itself to the wax and formed the mould into which the metal was to be poured.

A trough was cut at the top of the mould and channels leading to the wax core ensured ready access for the molten metal to the portions of the stern-frame to be united. Holes also were cut in the metal box to allow blow-lamps to be inserted, for the ends to be joined together had to be heated to redness; and provision was made for the wax core to run away when these blow-lamps were used.

The damaged stern-frame of the "Lafian" prepared for welding by cutting along the line of fracture by means of an oxy-acetylene torch.

Careful measurement of the gap to be filled showed how much steel was required, and the exact amount of the mixture of aluminium and oxide of iron needed to produce it was placed in a special crucible supported above the mould in such a position that the tapping hole in the bottom was directly over the trough in the sand box. In the meantime the blow-lamps had been started, and the preliminary heating operation in which they were used was continued for nearly four hours. The blow-lamps were then removed one by one and the spaces left in the sand mould plugged, after which a special flash powder lying on top of the Thermit mixture in the crucible was ignited by plunging a red-hot rod into it. There was a dazzling discharge of sparks that resembled a firework display, and in 30 seconds the harmless-looking white powder was transformed into alumina slag and molten steel.

As soon as the chemical reaction had spread completely through the mass in the crucible, a special plug was withdrawn in order to allow the molten metal to flow into the space prepared for its reception. Half an hour later the shore holding the two sections of the stern-frame in position was taken away so that the internal stresses would be automatically removed as the metal cooled and annealed itself. Later the mould was removed, and it was seen that the gap had been completely filled with new metal, the cross-section of which was a little greater than that of the stern-frame itself.



The "Lafian's" stern-frame after repair. The ship's plating is being electrically welded to the frame.

The preliminary heating had caused the rivets through the ends of the plates near the weld to become slack, and these were replaced; and as the connection of the plating to the stern-frame also had been affected by the heat, this was made secure by welding the plating electrically to the frame. Our second illustration shows the welder at work on this task.

The repair was completely successful, and examination of the "*Lafian*" in dry dock after her next voyage revealed no defect of any kind in her stern-frame. There appears to be a great future for this kind of repair work, especially when the only alternative is the renewal of the whole stern-frame, for Thermit welding can be carried out in much less time than would be required for this renewal and for the refitting that would then be necessary.

This interesting article and the photographs accompanying it have been supplied by A. W. Jackson, Wallasey.

British Marine Engine History in Meccano

IV.—The Reciprocating Engine Develops

IN last month's article we described the struggle between paddle wheels and the screw propeller, and the final adoption of the screw, towards the close of the 19th century, as the most effective method of marine propulsion. We showed also how, owing to the screw being a comparatively new thing, the means of operating it were for many years little better than experiments, the power units being at best effective only within narrow limits, and in many cases complete failures.

These early attempts, however, paved the way for scientifically-designed and better built engines that in time became more standard in general construction and more suitable for fitting into ships of almost any size. The main type of reciprocating engine that evolved is generally known as the steam-hammer engine on account of its close resemblance to the large forging hammers employed in iron and steel works. This type of engine no doubt would have come to the fore earlier but for the low freeboard and small draught of the early steamers; in warships, especially, the cylinder heads would have protruded far above the waterline and thus have been vulnerable to gunfire. This difficulty was overcome as the size of ships increased, and although in the early days of their introduction the engines had to be protected at their upper ends by armour, they quickly found favour, and have remained without important change up to the present day.

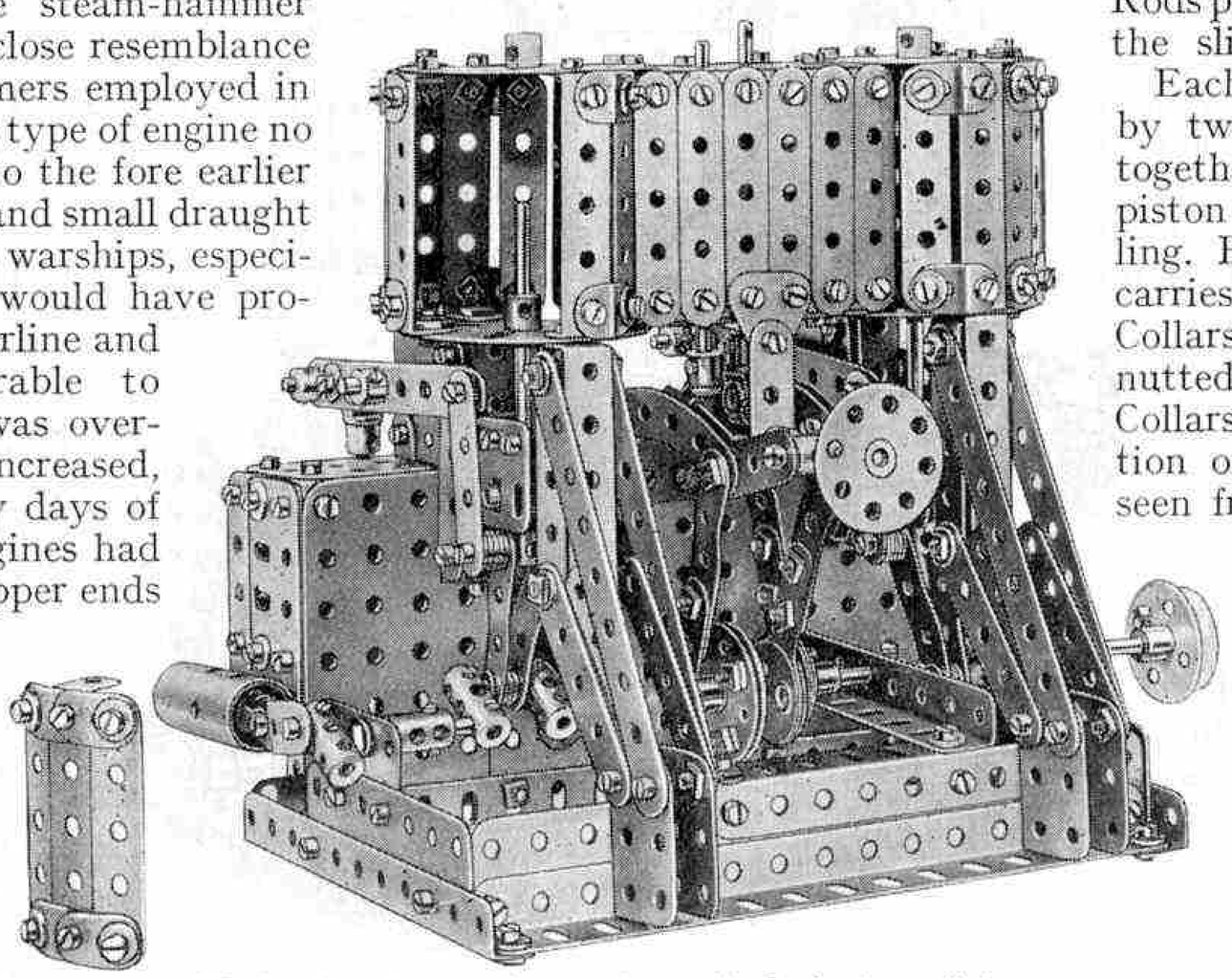


Fig. 1. An early steam-hammer type engine having two cylinders.

The majority of engines of this type were two-cylinder, simple-expansion, double-acting units, the cranks of which were set at an angle of 90 degrees to each other in order to overcome "dead centre." A model of one of these engines is shown in Fig. 1, the apparently odd section in the foreground being part of one of the cylinder walls, detached to show its construction and method of fitting.

The bed-plate of the model is built up from three $7\frac{1}{2}''$ and two $5\frac{1}{2}''$ Angle Girders, suitable Flat Girders being used as shown in order to give a massive appearance. To strengthen the complete frame 1" Corner Brackets are used. The condenser is next built, its near side being constructed from two $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Flat Plates, and the two ends from $2\frac{1}{2}''$ Flat Girders and Angle Girders. The top and the rear are composed of $3'' \times 1\frac{1}{2}''$ and $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plates, which are held in place by $7\frac{1}{2}''$ Angle Girders.

The crankshaft is the next portion to receive attention. Each crank consists of two Couplings held together by a 1" Rod, on which is carried the connecting rod represented by two 2" Strips. The right-hand side crank is carried on a 3" and a 2" Rod, and the left-hand side crank on a 2" and a 1" Rod, this last part being lengthened by means of a Coupling and Threaded Pin. The Threaded Pin is fitted with a second Coupling that carries the connecting rod of one of the auxiliary pumps. The two complete cranks are coupled together at right angles by means of a flexible connection built up from two Bush Wheels and four $\frac{3}{8}''$ Bolts. The $\frac{3}{8}''$ Bolts are lock-nutted as shown.

The construction of the cylinder block is clear from the illustration, and needs no comment except that the valve rods slide in the bosses of Double Arm Cranks fitted inside the block. The frames supporting the cylinders are built up round the four slide bars, each of which is represented by four $2\frac{1}{2}'' \times \frac{1}{2}''$ Double Angle Strips. The vertical frames are attached to these by means of 1" Threaded Rods passing completely through the slide bars.

Each cross-head is represented by two $1\frac{1}{2}''$ Flat Girders held together and attached to the piston rod by means of a Coupling. Each side of the cross-head carries a $\frac{3}{4}''$ Bolt fitted with two Collars, the Bolts being lock-nutted in order to allow the Collars to rotate. The construction of the valve gear will be seen from the photograph.

Two 2" Strips are pivotally attached to the lower edge of each cross-head, and are coupled by means of two $3\frac{1}{2}''$ and two $1\frac{1}{2}''$ Strips to a $1\frac{1}{2}''$ Rod carrying the circulating pump connecting rod. The two $3\frac{1}{2}''$ Strips are pivoted as shown on a $1\frac{1}{2}''$ Rod. The circulating pump, and its facsimile the air pump, are built up from two Bush Wheels and six $1\frac{1}{2}'' \times \frac{1}{2}''$ Double Angle Strips, the complete pumps being secured to the rear of the condenser by two Bolts each.

Soon after marine engines began to conform to a definite general design, compounding was introduced, this practice having been first applied to locomotives by Messrs. Samuel and Nicholson, of the Eastern Counties Railway, in 1852. The system as applied to ships met with immediate success, and two-cylinder compound engines were soon followed by triple and quadruple expansion types. In these engines the steam first entered the high-pressure cylinder, and after doing work there passed into a receiver where it remained until the valve opened to admit it into the next cylinder. Here it cooled, and if the engine was a two-cylinder compound the steam passed into the condenser, where it became water once more and was ready for using over again in the boilers. Triple and quadruple expansion engines used steam in an exactly similar manner, except that expansion was spread out

over three or four cylinders, a receiver being incorporated between each separate stage of expansion.

All big vessels built after the introduction of compounding were fitted with triple or quadruple expansion engines, the cylinders of which were arranged in one line, and a separate crank used for each. In older vessels, however, this system was impracticable on account of restricted engine room space, more than two cylinders in line being very rarely used in simple expansion engines. It was a great advantage to fit these vessels with compound engines, however, and a system of tandem cylinders was therefore introduced in order to overcome the difficulty. In these engines the cylinders were arranged one above the other in pairs, each pair having one common connecting rod and crank. In this manner most of the advantages of three and four stages of expansion were obtained with only a slight increase in height, and as this could readily be accommodated by the removal of the upper deck, the efficiency of a vessel so fitted was considerably increased without the cargo-carrying space being affected. This type of engine lasted only as long as these older vessels were afloat, however, and therefore in recent years it has entirely died out, new vessels now being built to accommodate longer but lower engines.

An excellent scale model of a four-cylinder, triple-expansion, tandem engine is shown in Fig. 2, the cylinders of this being so arranged as to give one high-pressure, on intermediate—and two low-pressure cylinders.

Commence building the model by constructing the base, each side of which is formed from a $9\frac{1}{2}$" Angle Girder and a $9\frac{1}{2}$" Flat Girder. These two members are coupled together by four $5\frac{1}{2}$" Angle Girders and Flat Girders of similar length, the complete base being made rigid by four large Corner Brackets. One $3\frac{1}{2}$" Angle Girder and two $1\frac{1}{2}$" Angle Girders are now attached by means of $1\frac{1}{2}$" Strips to the near side of the base as shown, and the outer edges of these carry the lower ends of the $5\frac{1}{2}$" Angle Girders representing the outer vertical frames. The inner vertical frames are built up from $2\frac{1}{2}" \times \frac{1}{2}"$ Double Angle Strips, $2\frac{1}{2}$" Strips and Channel Bearings, the Double Angle Strips forming one side of the slide bars. The other side is formed from one $2\frac{1}{2}" \times \frac{1}{2}"$ Double Angle Strip and two $2\frac{1}{2}$" Strips, and the complete unit is secured at the top by a Double Bracket and at the bottom by two Flat Brackets and a Double Bracket. The cross-heads are each formed from two $1\frac{1}{2}$" Flat Girders held together and attached to the piston rod, a $6\frac{1}{2}$" Rod, by a Coupling. The connecting rod, represented by a 3" Rod, is secured pivotally to the cross-head by a Small Fork Piece and to the crankshaft by a Coupling. The construction of the crankshaft and valve gears is shown in Fig. 2.

Each of the two low-pressure cylinders is composed of two Face Plates connected together by five $3\frac{1}{2}" \times \frac{1}{2}"$ Double Angle Strips, the spaces between the Double Angle Strips being filled in by $3\frac{1}{2}$" Strips held in place by Flat Brackets. An extension is fitted to one side of the cylinder to represent the slide valve chest, and this is built up from two sets of $2\frac{1}{2}$" large radius Curved Strips and a $1\frac{1}{2}$" Flat Girder connected together by $3\frac{1}{2}$" Strips. These $3\frac{1}{2}$" Strips are carried on suitably-shaped $2\frac{1}{2}$" Strips. The valve chest cover is composed of three $3\frac{1}{2}$" Strips held together by two $1\frac{1}{2}$" Strips and attached to the valve chest by means of four Bolts, the holding Nuts of which are placed outside for accessibility.

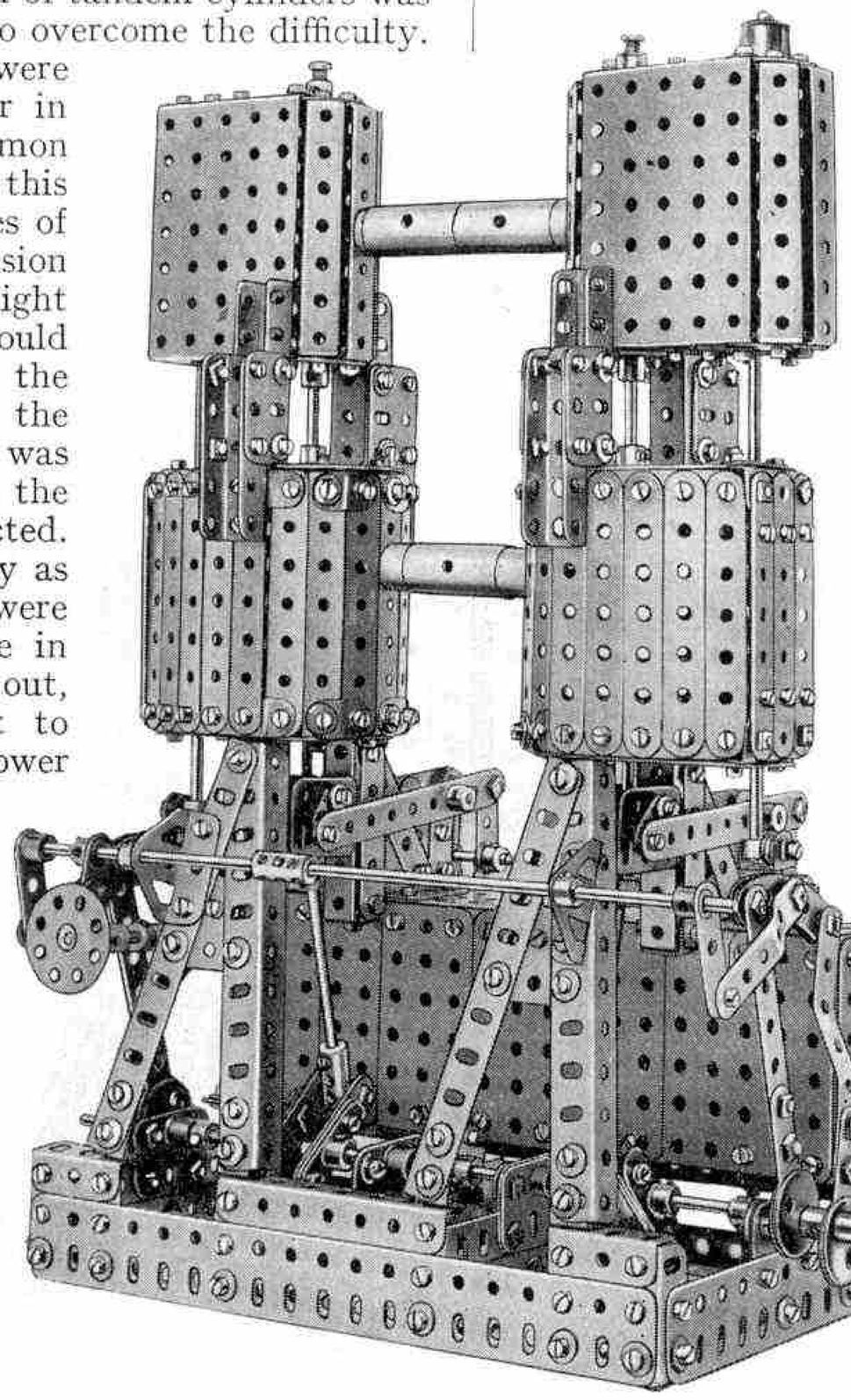


Fig. 2. A fine model of a tandem engine, a type of power unit adapted for use in old vessels as described in this article.

The two complete low-pressure cylinders are now connected together by a dummy steam pipe built up from a Sleeve Piece and two Chimney Adaptors, a 2" Threaded Rod being used to hold them in place. The upper part of each cylinder carries two supports by means of which the high- and intermediate-pressure cylinders are attached to their respective low-pressure cylinders. The construction of the high-pressure cylinder, it will be noted, differs slightly from the intermediate-pressure cylinder, as the former is fitted with a piston valve instead of a slide valve, common to the other cylinders.

The arrangement for operating the air and circulating pumps is similar to that described for Fig. 1, except that the pumps are built up from $2\frac{1}{2}" \times \frac{1}{2}"$ Double Angle Strips instead of $1\frac{1}{2}" \times \frac{1}{2}"$ Double Angle Strips.

Although at this period almost all marine engines were of the vertical, reciprocating type, for some purposes horizontal direct-acting engines were still employed, good examples of these being found in the light cruisers and destroyers built during the latter part of last century. These engines were intended for very fast and light vessels having little draught and low freeboard, and in which weight was the main consideration. In general appearance they resembled the return-connecting rod type of engine described last month, but a direct-acting connecting rod was used in place of the return arrangement of the earlier power plant. The great disadvantages of these engines were the short connecting rods and uneven cylinder wear, and for these and other reasons they became obsolete as soon as fast naval vessels became large enough to accommodate vertical direct-acting engines, without the use of too much armour.

We now come to the period when fast direct-acting vertical engines definitely became established as the best and most efficient type for marine work, and from about 1900 onward all but the smallest vessels were fitted with either triple- or quadruple-expansion vertical engines. Triple-expansion engines have usually found more favour than those having four stages of expansion, on account of their smaller bulk and fewer main shaft bearings, this

latter point being of major importance, for the longer the bed-plate of the engine the greater are the possibilities of its being distorted, thereby decreasing the efficiency of the engine through friction.

Now that one type of engine had definitely become generally accepted it was natural that engineers should give more thought to its efficiency and the possibilities of higher speeds, and it was not long before a race for faster and more powerful vessels began, especially between the countries of the Western seaboard of Europe. Foremost among these were England, Germany and France, Holland and Italy coming later as their knowledge of marine engineering increased. As a result of this competition British engineers, and especially those from Clydebank, designed and constructed some remarkably fast, light and efficient engines, most of which were three-cylinder, triple-expansion power units. As competition increased the call for higher speeds became more and more insistent until by about the year 1906 the majority of vessels, large and small, were driven by amazingly efficient triple- and quadruple-expansion engines, those fitted into the bigger liners being capable of driving the vessels at speeds of over 18 knots. This was the climax of the high-speed reciprocating engine, however, for about this time the possibilities of the turbine method of propulsion were beginning to be realised. From then onward reciprocating engines began to decrease in number, and were applied only to slower ships, such as cargo vessels and oil tankers. The introduction and rapid climb of the turbine will be described next month.

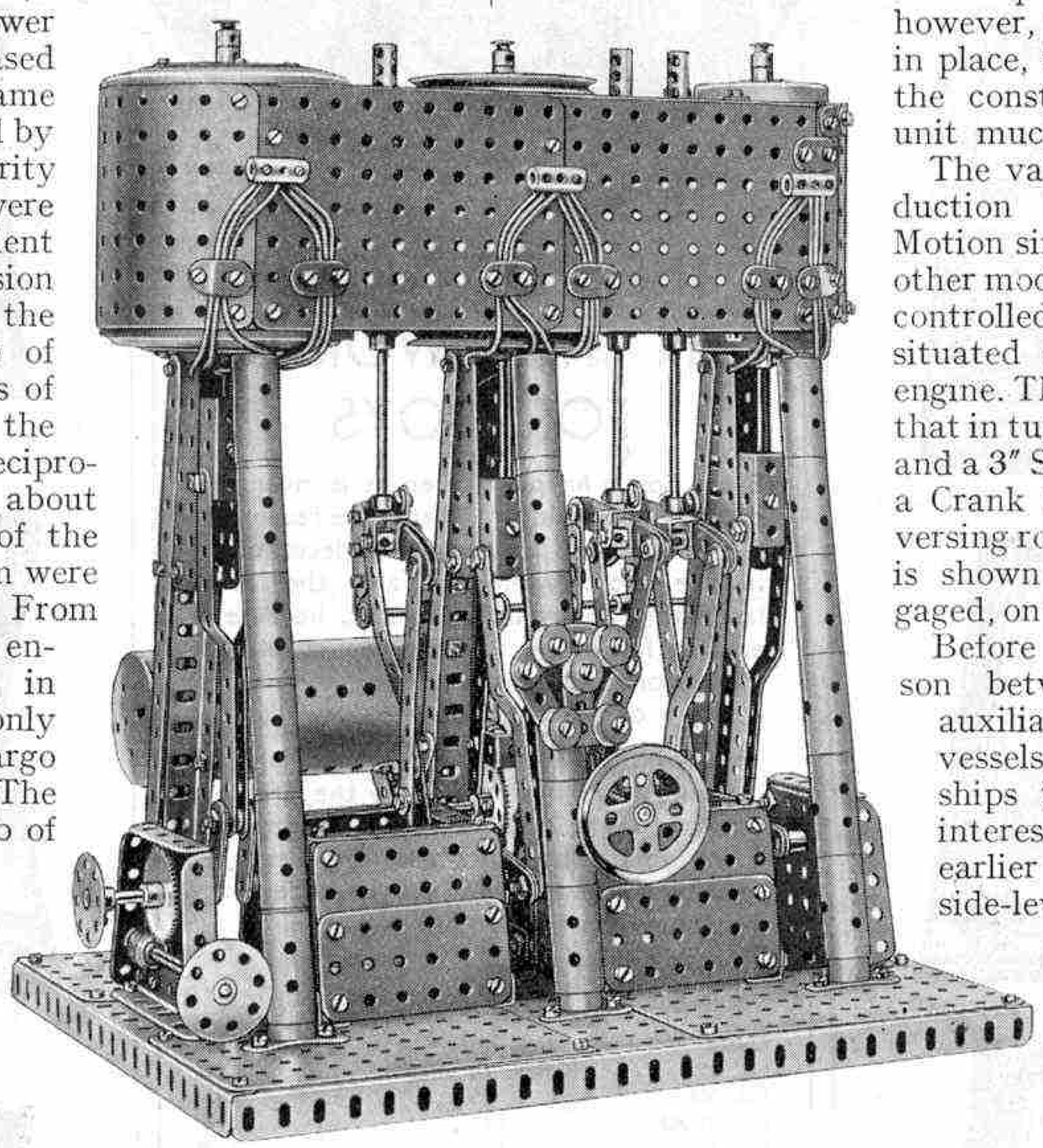


Fig. 3. The compact and efficient appearance of a modern marine engine is well illustrated by this fine Meccano model.

For ships in which high speed is of less importance than absolute reliability combined with simplicity, reciprocating engines still reign supreme, and they are so perfectly adapted to their task that it is unlikely that they will be replaced for many years to come by turbines or any other form of propulsion. A modern type of normal triple-expansion engine is shown in model form in Fig. 3. This is a particularly fine model, and gives a graphic idea of the compact and symmetrical design of engines of this type.

The base of this model differs slightly from that of the two previous models described in the article, as it represents the floor of the engine room and not the actual bed-plate of the engine. It is constructed from two $12\frac{1}{2}''$ and two $9\frac{1}{2}''$ Angle Girders, the frame so formed being covered in by $5\frac{1}{2}'' \times 3\frac{1}{2}''$ Flat Plates. A space $2\frac{1}{2}''$ wide is left between the two rows of Flat Plates, and the inner edges of the Plates are supported on two $12\frac{1}{2}''$ Angle Girders. Each of the main shaft bearings is constructed from a $2\frac{1}{2}'' \times 2\frac{1}{2}''$ Flat Plate and three $2\frac{1}{2}''$ Angle Girders, the complete bearing being secured in place by a $3\frac{1}{2}''$ Angle Girder. The four inner bearings are coupled together in pairs by $3'' \times 1\frac{1}{2}''$ Flat Plates. The construction of the crankshaft is shown in the illustration.

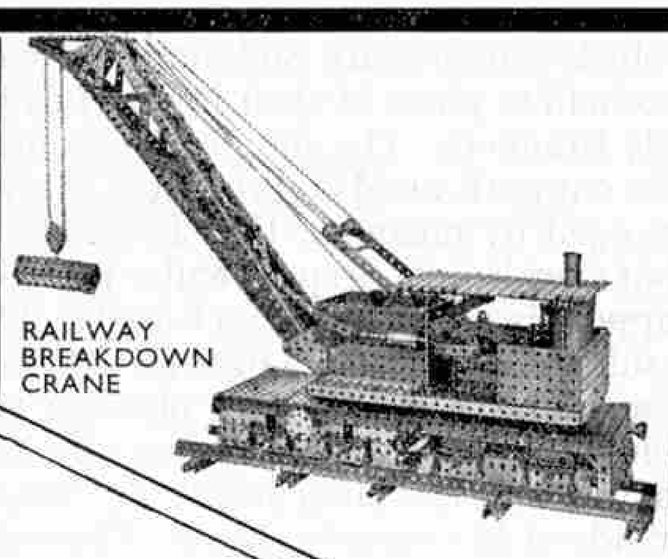
The rear cylinder block supports are each built up from two $9\frac{1}{2}''$ Angle Girders held in place at their lower ends by means of $1'' \times 1''$ Angle Brackets. The slide bar is secured to the upper end of the support, and is represented by two $3\frac{1}{2}''$ Flat Girders, arranged by means of Flat Brackets at their lower ends so that they lie in a perpendicular position when the cylinder support is set at its correct angle. The supports on the near side each consist of a $6\frac{1}{2}''$ and a $3''$ Rod secured together by a Coupling and held in place at the lower end by a Double Arm Crank. At its upper end this compound rod is attached by a Coupling and $1'' \times 1''$ Angle Bracket to the under side of the cylinder block. The solid appearance is given to the rod by the use of Sleeve Pieces and Chimney Adaptors.

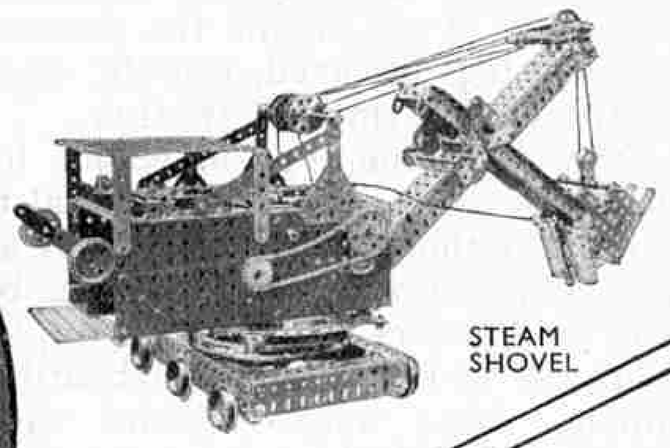
The cylinder block is shown clearly in the illustration and therefore needs no description. It should be noted, however, that the top is not bolted in place, this arrangement making the construction of the cylinder unit much simpler.

The valve gear is a scale reproduction of Stephenson's Link Motion similar to that fitted to the other models in this article, and it is controlled from the hand wheel situated on the near side of the engine. This wheel operates a Worm that in turn rotates a 57-teeth Gear, and a $3''$ Strip connects this Gear to a Crank mounted on the link reversing rod. The hand turning gear is shown with the Worm disengaged, on the near end of the engine.

Before going further a comparison between the engine room auxiliaries found in modern vessels and those found in earlier ships will no doubt prove of interest. A glance at one of the earlier engines, for example, the side-lever engine described in the April issue, will show how the main engine was made to operate practically all the pumps and other machinery in the engine room. The model named is a very good example, for the beams of the original engine were literally covered with levers operating a variety of pumps, valves, etc. As the construction of marine engines has progressed, however, more and more auxiliaries have been detached and driven by separate motors until, as will be seen from Fig. 3, not even the air and circulating pumps are operated from the engine. Thus the work of the main power unit is concentrated entirely on driving the propeller, while the auxiliaries are in many cases operated at reduced pressure through a reducing valve from the main steam supply. Even the condenser, shown in the model fitted to the frames of the engine, is often separate and placed between the engine room and boiler room.

Within the past three years reciprocating engines have undergone a considerable amount of alteration and improvement, especially in connection with the valves and valve gears; and some of these improvements, together with modern turbine installations, will be described in next month's issue.


RAILWAY BREAKDOWN CRANE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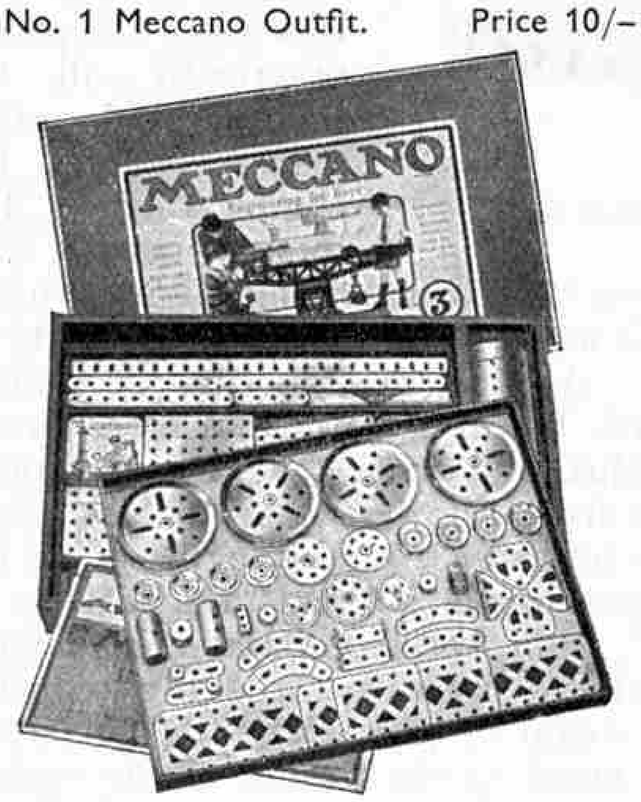

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No. O	,,	343 ,,	...	5/–
No. 1	,,	573 ,,	...	10/–
No. 2	,,	629 ,,	...	16/–
No. 3	,,	687 ,,	...	27/6
No. 4	,,	753 ,,	...	52/6
No. 5 (Carton)	,,	798 ,,	...	70/–
No. 5 (Cabinet)	,,	798 ,,	...	100/–
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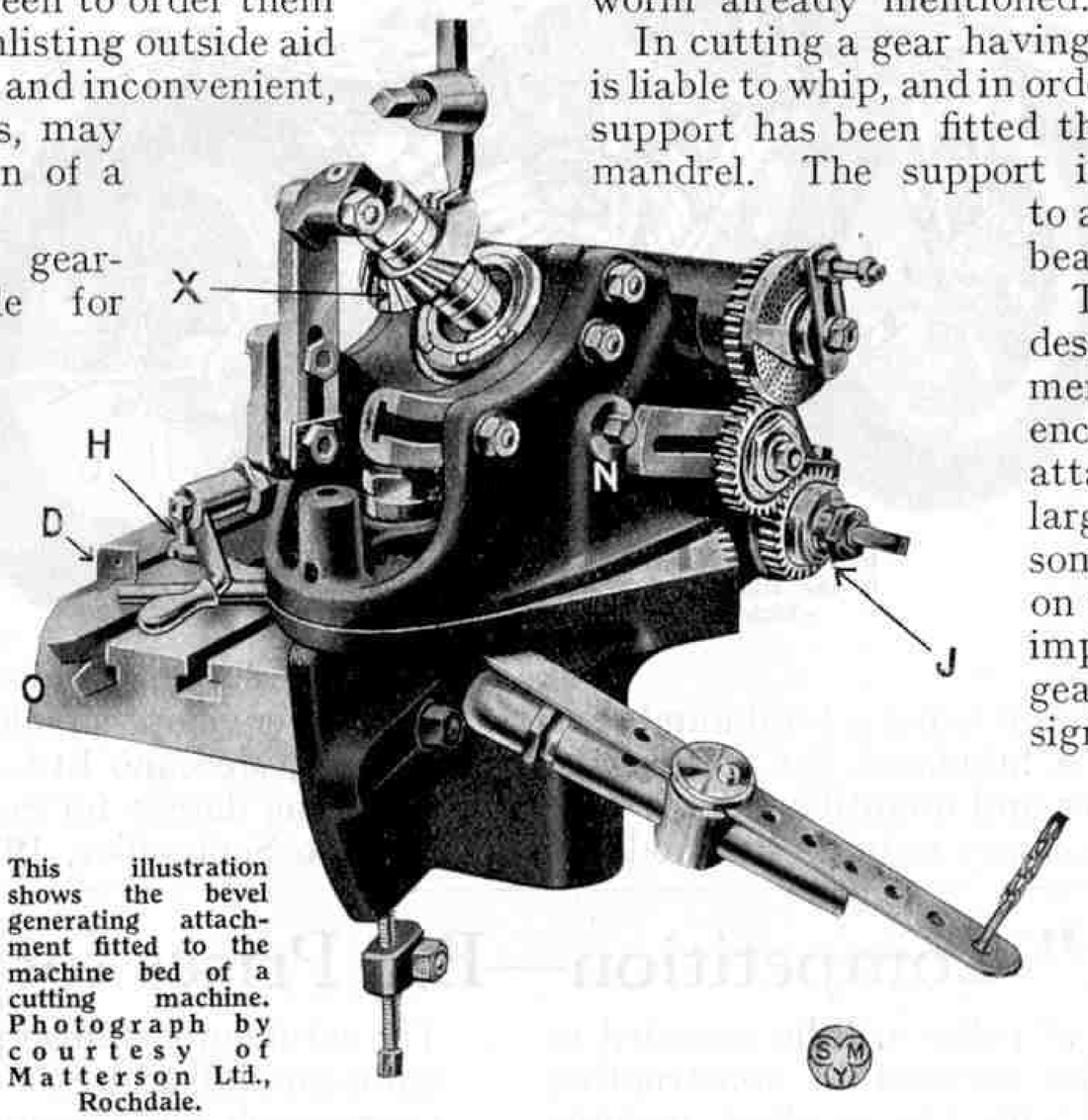
MECCANO

Spur and Bevel Gears Cut on an Ordinary Lathe

Three Useful Attachments

UNLESS a special gear-cutting lathe is available, the production of gears is seldom, if ever, undertaken by either amateur mechanic or manufacturer when it is possible to obtain the services of a firm that concentrate on gear cutting, and have all the required plant at their disposal. The amateur is usually unable to obtain the necessary lathe for financial reasons, while the manufacturer finds that it does not pay to keep a large machine as part of his plant when it is used only occasionally. The only method of obtaining the necessary gears, therefore, has been to order them from outside. This system of enlisting outside aid for such work is naturally costly and inconvenient, and days, and sometimes weeks, may be necessary for the completion of a single job.

Recently three interesting gear-cutting attachments, suitable for fitting to ordinary lathes, have been introduced by Matterson Ltd., of Rochdale. These attachments are remarkably compact, and can be fitted to a lathe in a very short time. Their cost is only a small fraction of that of an actual gear-cutting machine, and they are capable of turning out almost any type of bevel and spur gear.



This illustration shows the bevel generating attachment fitted to the machine bed of a cutting machine. Photograph by courtesy of Matterson Ltd., Rochdale.

The bevel gear-cutting attachments are available in two sizes, which are able to turn out gears having diameters up to 6 in. and 12 in. respectively. The spur gear attachment is able to cut gears having a diameter of not more than 12 in., and also step-cluster gears for use in car gear boxes.

The base of the bevel-cutting attachment consists of a cast steel quadrant, teeth for swinging the mandrel being cut round the curved portion of the casting. A vertical lug, cast with the quadrant on its underside, is provided with a system of slots by means of which it is possible to fit the complete attachment to a great number of different machines. The top of the quadrant is machined perfectly level, and on this swings a second casting that carries the mandrel and its operating mechanism. This second casting is attached to the quadrant by a steel pivot, and is made to swing from side to side by means of a worm engaging with the toothed segment of the quadrant.

The mandrel is a solid steel rod on which the gear blank is placed prior to cutting. It is mounted in rocker bearings, and the amount of tilt given to the gear is controlled by a graduated handle that rocks the mandrel through skew gears.

The dividing for various numbers of teeth is effected by means of a graduated handwheel. The slide traverse movements in generating the teeth are automatically operated, however, by a pawl and ratchet wheel, the pawl being rocked by means of a lever that is operated from the sliding tool holder of the lathe or shaping machine. The connection between the lever and the tool head is formed by a chain and screw adjuster.

In making spiral bevel gears the tool is offset from the centre of the gear blank by swinging the mandrel casting to one side of the quadrant by means of the worm already mentioned.

In cutting a gear having very deep teeth the mandrel is liable to whip, and in order to prevent this an outboard support has been fitted that is able to swing with the mandrel. The support is also adjustable, in order to allow any wear in the mandrel bearings to be taken up.

The foregoing is a general description of the 6 in. attachment, and there is little difference between this and the 12 in. attachment, except that the larger one is naturally made somewhat heavier and stronger, on account of the greater strain imposed on it in cutting large gears. The larger fitting is designed for bolting direct to the top of a machine table, and has a different arrangement for tilting the mandrel, an additional slide being provided to give the attachment greater strength.

As already mentioned, in addition to the two bevel gear cutters Matterson Ltd. supply a spur gear-cutting attachment that is capable of dealing with gears having diameters not exceeding 12 in. This attachment is much simpler than the one that has been described, because of the mandrel being set horizontally instead of at an angle. The mandrel is mounted in a heavy casting at one end, and in a steel bearing at the other, sufficient space being left between the two to enable the fitting to handle gears having a maximum face of 6 in. The dividing for the teeth is effected by hand, but the mechanism for shaping the teeth is automatic, the drive being transmitted from the tool slide by means of chain and gears.

The introduction of these gear-cutting attachments reduces gear production both for the amateur and for the manufacturer to its simplest possible form, and although they are somewhat slower than automatic lathes built for the same purpose, they are absolutely accurate in every way. They are capable of cutting gears from almost any material including mild steel, a material which only the most expensive automatic lathes are capable of dealing with.

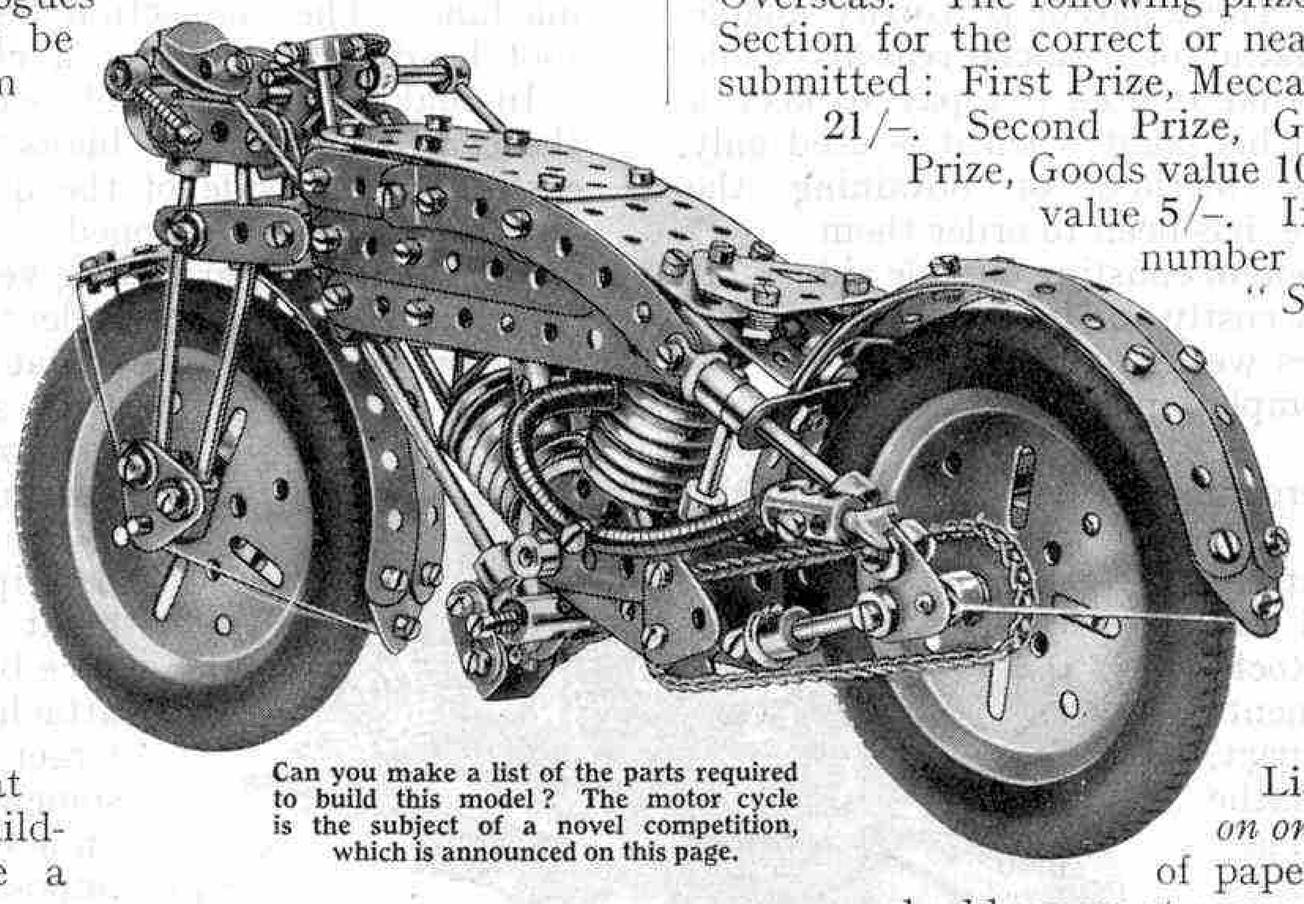
Meccano Competitions Open to All Readers

Novel "Parts Required" Contest

In this Competition readers are invited to test their skill in making a list of all the Meccano parts used in building the fine model motor cycle illustrated on this page. In sending in their entries competitors must state the Meccano catalogue number of each part and the quantity required. Catalogues of Meccano parts may be obtained on request from Meccano dealers.

In entering this Contest it is simply a matter of skill in estimating correctly the parts embodied in the model. As some portions of the motor cycle cannot be seen in the illustration, each competitor must calculate the necessary parts by basing his estimate on the manner in which he personally would construct the model, and it is here that a competitor's model-building experience will be a valuable aid.

Competitors should note that it is not a total number of parts that is required, but a tabulated list stating the name, catalogue part number and quantity of each part that they think would be necessary to build the model as illustrated. Each competitor is allowed one attempt only, but every reader young or old is eligible to compete in the Contest.



Can you make a list of the parts required to build this model? The motor cycle is the subject of a novel competition, which is announced on this page.

Entries will be divided into two sections: (A) for readers living in the British Isles, (B) for readers living Overseas. The following prizes will be awarded in each Section for the correct or nearest correct lists of parts submitted: First Prize, Meccano or Hornby goods value 21/–. Second Prize, Goods value 15/–. Third Prize, Goods value 10/6. Five prizes of Goods value 5/–. In addition there will be a number of consolation awards of "*Standard Mechanisms*" Manuals.

The bigger prizes will go to those competitors whose lists are quite correct or contain the least number of errors, and the smaller prizes will be forwarded to the competitors whose lists are next in order of merit.

Lists of parts must be written *on one side only* of a plain sheet of paper. The competitor's full name, and address must appear on the back of the entry, and the envelope should be addressed "Parts Required" Contest, Meccano Ltd., Binns Road, Liverpool 13.

Closing dates: for Section A, 31st July, 1934; Section B, 29th September, 1934.

"Simplicity" Competition—Big Prizes for Small Models

In this Contest a number of prizes will be awarded to Meccano model-builders who succeed in constructing the most ingenious models with the smallest possible number of parts.

It is of course quite easy to bolt together two or three Strips and a Pulley or two, and call the finished model a crane or a motor car, but such a model will not win a prize in this Contest. Competitors should first choose a suitable subject and then build their models with the smallest possible number of parts consistent with a realistic effect. It must not be thought, however, that competitors are limited to any specified size of Outfit or quantity of parts. Competitors may use any number or variety of parts that they wish, but the prizes will be awarded to those boys who succeed in constructing the most ingenious models from the smallest number of parts.

When the model is completed the competitor should obtain either a photograph or a good drawing of it and then send this to "Simplicity" Model-Building Contest, Meccano Ltd., Binns Road, Liverpool 13. The actual model must not be sent. The competitor's age, name and full address must be written on the back of each photograph or drawing submitted for consideration.

Entries will be divided into two Sections as follows: Section A, for readers of all ages living in the British Isles, and Section B, for Overseas readers of all ages.

July 31st, 1934, is the last day on which entries will be received from competitors living in the British Isles. Overseas readers must forward their entries so that they reach Liverpool not later than 29th September, 1934.

Photographs or drawings of prize-winning models become the property of Meccano Ltd., but unsuccessful entries will be returned to the senders if a stamped addressed envelope of the correct size is enclosed with the entry.

Competitors should remember that in this Contest the object is not to build the smallest models possible, but models in which the least possible number of parts is used, consistent with a realistic effect. Competitors may submit more than one model if they wish.

"Simplicity" Model-Building Contest

The Prizes

The following set of prizes will be awarded in each of the Sections A and B.

First Prize, Meccano or Hornby Goods value £2-2s.
Second Prize, Meccano or Hornby Goods value £1-1s.
Third Prize, Meccano or Hornby Goods value 10/6.
Ten Prizes of Meccano or Hornby Goods value 5/–.

There will also be a number of consolation awards consisting of Meccano or Hornby Goods value 2/6, and Certificates of Merit.

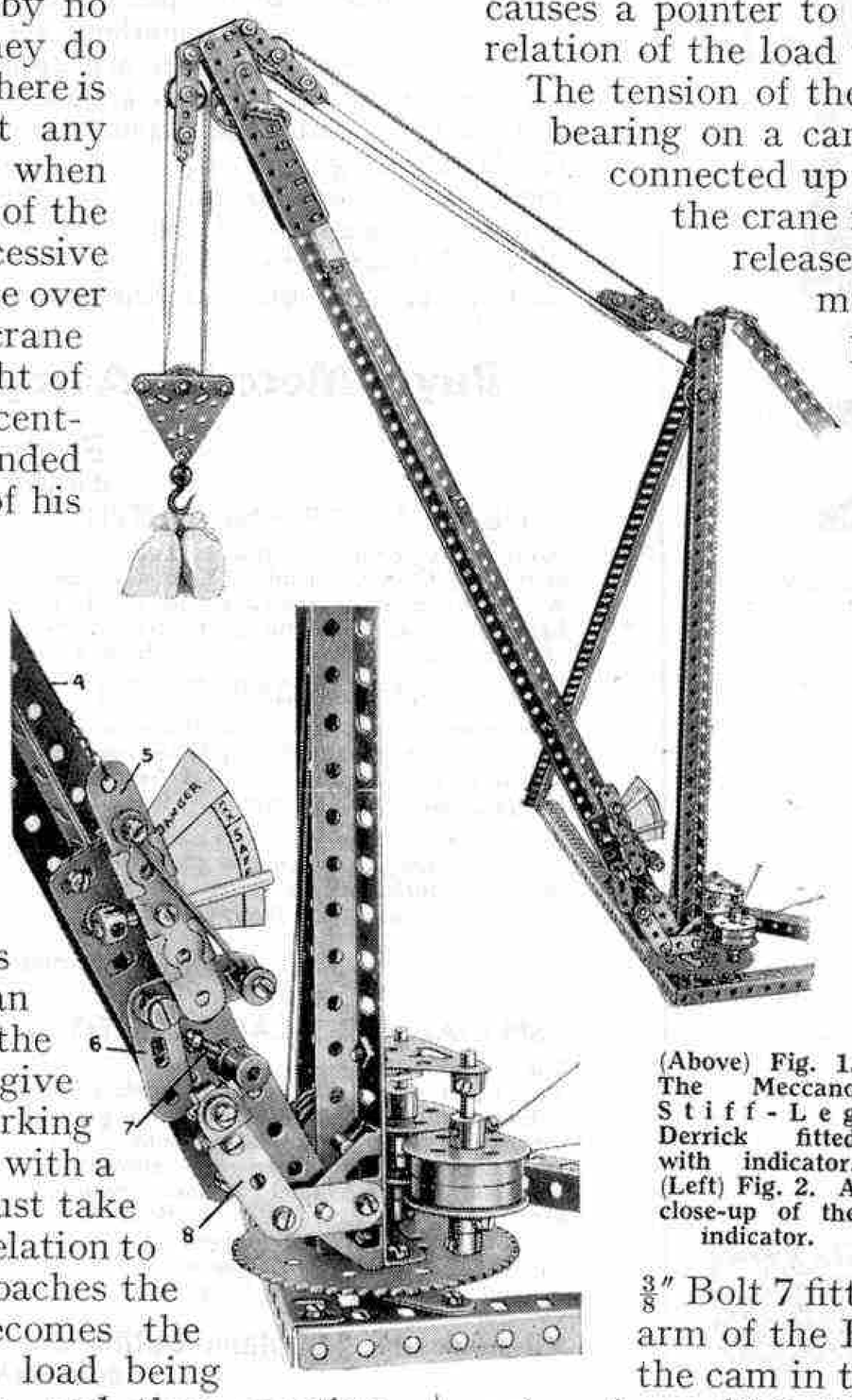
A Safe Load Indicator for Cranes

Interesting Addition to Stiff-Leg Derrick

HUGE cranes handling immense loads are such a familiar sight nowadays that probably few of us stop to think of the dangers that are encountered in the process. Crane accidents are by no means rare, however, and when they do occur they are generally serious. There is a definite limit to the load that any particular crane can handle, and when this limit is exceeded certain parts of the structure may collapse under the excessive strain, or the entire crane may topple over and crash to the ground. The crane driver rarely knows the exact weight of the load he is handling, and until recently the safety of the operations depended upon his good judgment and that of his "slinger." Frequently the driver cannot see the load that is being raised, and even if this is known to be well within the safety limit, it may become caught in some obstruction, and then unless the driver receives timely warning a more or less serious accident may result.

There is now a regulation that cranes used in certain operations must be fitted with an indicator of an approved type to show when the maximum load is reached, and to give warning immediately the safe working limit is exceeded. On cranes fitted with a derricking jib, such an indicator must take into account the angle of the jib in relation to the load. The nearer the jib approaches the horizontal position the lower becomes the safety limit. This is due to the load being farther from the pivot of the jib, and thus exerting a greater leverage.

An ingenious mechanism that indicates to the driver the degree of safety with any load and at any inclination of the jib is produced by Vickers-Armstrongs Ltd., to whom we are indebted for the illustration of the actual device in Fig. 4, and for much useful information. The mechanism is known as the Vickers-Nash Safe Load Indicator, and in addition to the part illustrated in Fig. 4 there is a special fitting for the jib-head pulley. The pulley is mounted on an eccentric arranged in such a manner that the weight on the hoisting cord tends to turn the eccentric. A tension arm attached to the eccentric is connected to a sliding rod on the indicator, the rod being provided with a stout compression spring to counteract the pull. When a heavy load is being raised there is a greater pull on the sliding rod and the spring is compressed; and the rod causes a pointer to move across a scale to indicate the relation of the load to the safety limit.



(Above) Fig. 1. The Meccano Stiff-Leg Derrick fitted with indicator. (Left) Fig. 2. A close-up of the indicator.

The tension of the spring is governed by a bell crank bearing on a cam. The cam is fitted with a lever, connected up in such a manner that, as the jib of the crane is lowered, the compression spring is released so that it requires a lighter load to move the pointer to the danger position. When the danger mark is reached an electric alarm bell is brought into operation to warn the crane driver.

The Meccano Stiff-Leg Derrick fitted with a model of the Vickers-Nash Indicator is shown in Fig. 1, and a more detailed view of the mechanism appears in Fig. 2. The arrangement at the jib-head is shown in Fig. 3, and it will be seen that the Pulley 1 is supported on a 1" Screwed Rod rigidly secured to two Double Arm Cranks 3. The Coupling 2 is carried on the same Rod as one of the Cranks, and a length of wire 4 connects with the mechanism shown in Fig. 2.

The connecting wire is attached to the 3" Strip 5, which is free to slide in two Eye Pieces. Spring Cord is attached to the Strip and to one arm of the Bell Crank 6. A $\frac{3}{8}$" Bolt 7 fitted in a Collar bears against the other arm of the Bell Crank and serves the purpose of the cam in the actual mechanism. The Collar is gripped on a $\frac{3}{4}$" Bolt that is screwed into a Threaded Boss so that the two are fixed securely together. A Threaded Pin is screwed into one of the tapped bores of the Threaded Boss, and carries a Collar to which a Reversed Angle Bracket is pivoted and connected by the $1\frac{1}{2}$" Strip 8 to a fixed $1\frac{1}{2}$" Strip attached to the base of the crane. As the jib is raised the $\frac{3}{8}$" Bolt 7 depresses the Bell Crank 6, thus increasing the tension of the Spring Cord. The pointer consists of a 2" Axle Rod pivoted on a bolt inserted in the tapped bore of a Collar, and connected to the sliding Strip in a similar manner.

The scale can be cut from a piece of stiff white card and should be marked off to indicate "Danger," "Maximum Load" and "Safe Load" as illustrated.

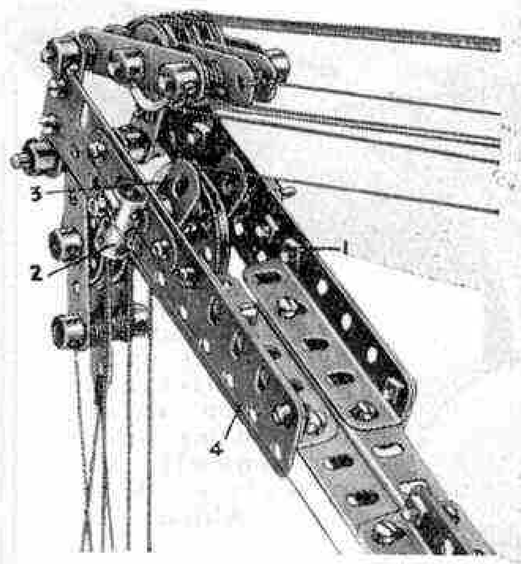


Fig. 3. The jib head pulley arrangement.

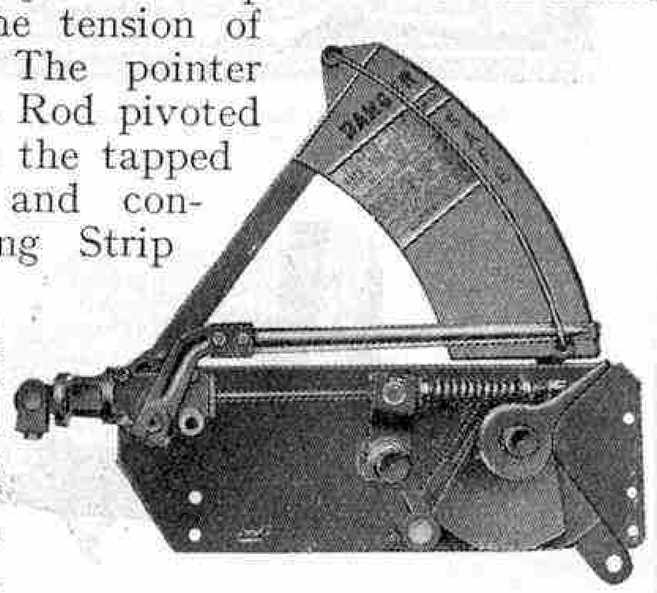
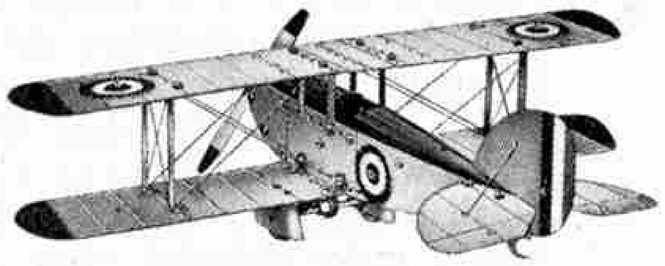


Fig. 4. Vickers-Nash Indicator with cover plate removed.

MECCANO

No. 1 Meccano Aeroplane Outfit. Price 9/-



Model of a Standard Light Biplane built with No. 1 Aeroplane Outfit.

Model of a Light Biplane built with No. 2 Special Aeroplane Outfit.

No. 2 Special Meccano Aeroplane Outfit. Price 25/-

AEROPLANE CONSTRUCTOR

Boys, Meccano Aeroplane Outfits are great! They enable you to build wonderful models of aeroplanes—the most realistic you ever saw.
If you want to know something about aeronautics the first step is to understand how aeroplanes are designed and constructed, so that you may be able to recognise at a glance the different types of machines.
A beautifully illustrated Manual is included in each Meccano Aeroplane Outfit showing how to build a number of different models, both monoplanes and biplanes. Many other splendid models may be built by varying the position of the parts, which are all interchangeable on the famous Meccano principle. The parts in the Nos. 1 and 2 Outfits can be used in conjunction with the standard Meccano parts.

Buy a Meccano Aeroplane Outfit To-day!

Price List

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An interesting range of models can be built with this Outfit, including high and low wing monoplanes, seaplanes and standard light biplanes. All the parts are interchangeable. Price 5/-

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Note. The parts in the No. O and No. O1P Aeroplane Outfits are smaller than those in the other Outfits in the series and are not intended for use with these Outfits.

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Magnificent models of high and low wing monoplanes, and interesting model biplanes representing standard types can be built with this fine Outfit. Price 9/-

Meccano Aeroplane Accessory Outfit No. 1a, costing 8/6, will convert a No. 1 Outfit into a No. 2.

No. 2 AEROPLANE OUTFIT

This Outfit enables a much wider range of models to be built, including triple-engined monoplanes and biplanes, and a racing seaplane of the type that was used in the Schneider Trophy Contests. Price 16/6

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The parts in this super Aeroplane Outfit will build over 20 realistic models of different types of aircraft. The range of special parts includes main planes fitted with ailerons, tail planes with elevators, movable rudder, radial engine cowling, etc. Price 15/-

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This is the finest and most attractive Aeroplane Constructor Outfit on the market. It contains a big range of aircraft parts, with which numerous models of practically any type of machine may be built—44 examples are shown in the Manual of Instructions. All the parts that are features of the No. 1 Special Outfit are included, also a number of other parts of special design. Price 25/-

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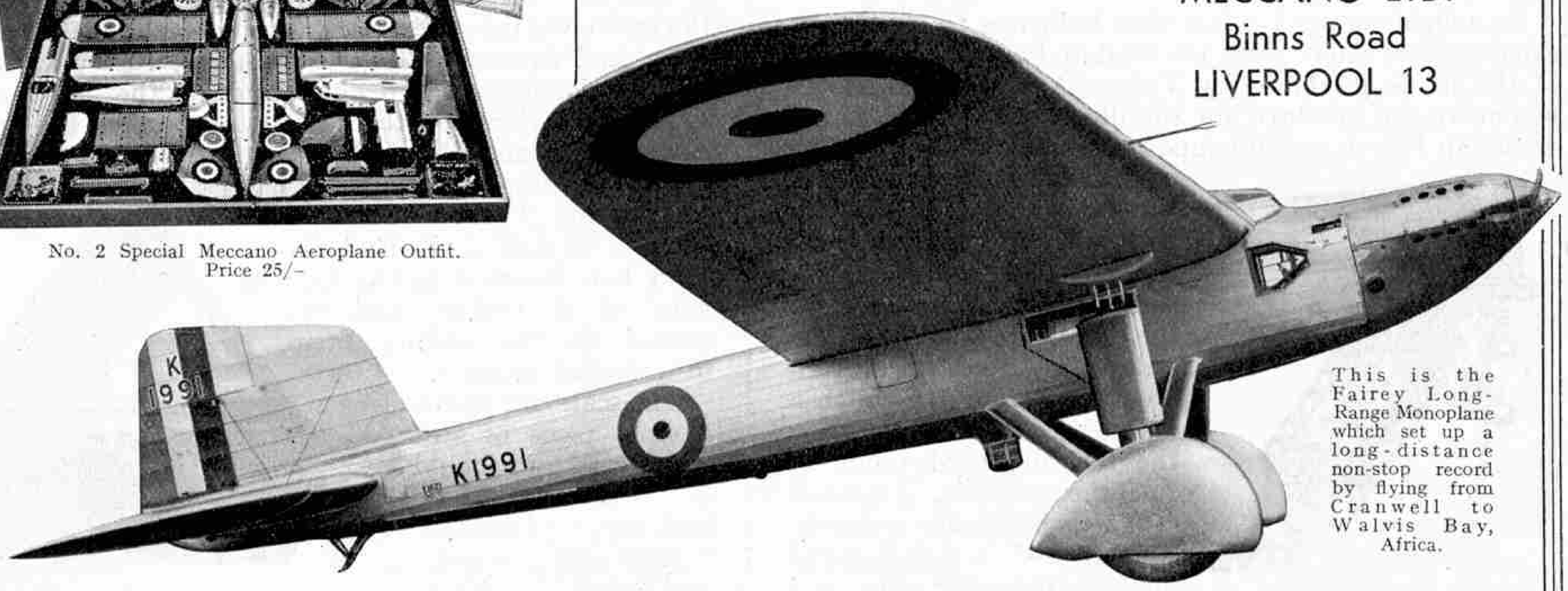


This is the Fairey Long-Range Monoplane which set up a long-distance non-stop record by flying from Cranwell to Walvis Bay, Africa.

Model-Building Competition Results

By Frank Hornby

"Autumn" Contest (Overseas Section)

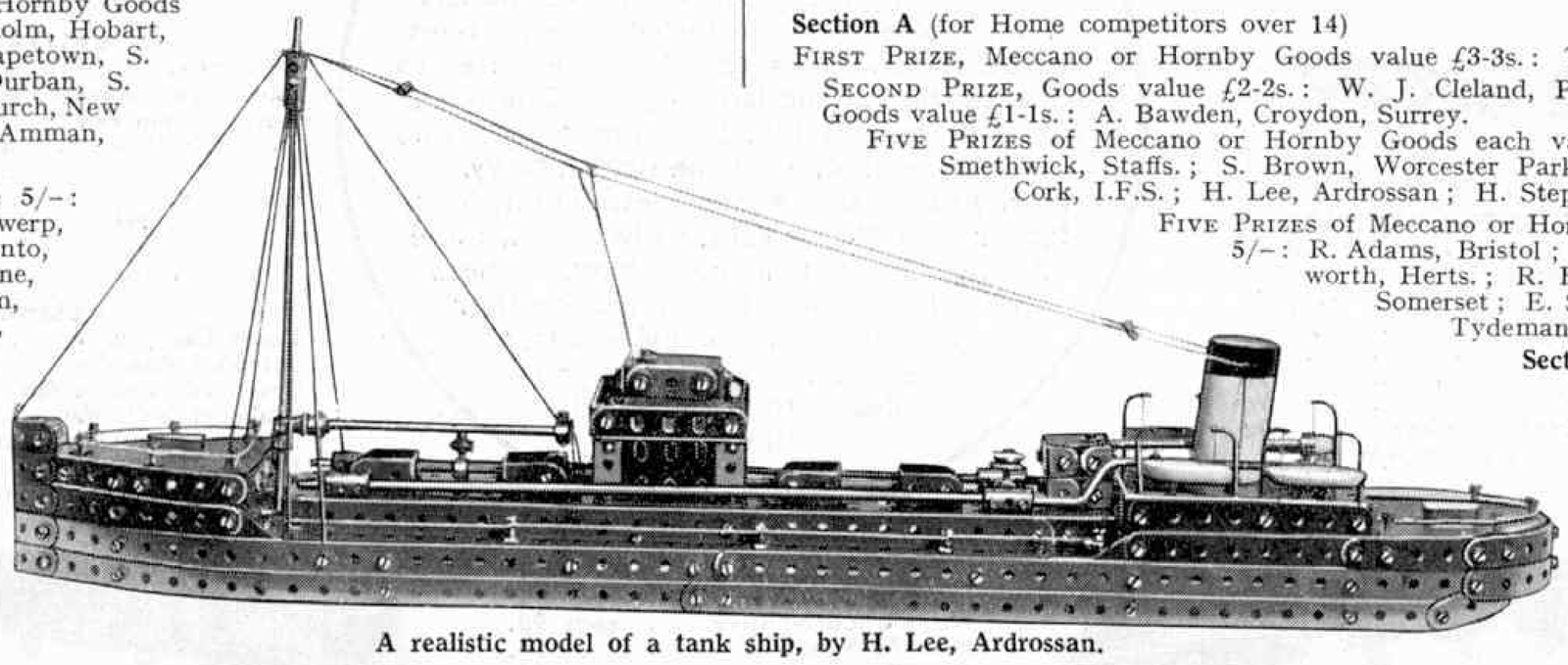
The complete list of awards in the Overseas Section of the 1933 "Autumn" Model-Building Contest is as follows :

FIRST PRIZE, Meccano or Hornby Goods value £3-3s. : L. Wilkinson, Regina, Canada. SECOND PRIZE, Goods value £2-2s. : P. Giese, Buenos Aires. THIRD PRIZE, Goods value £1-1s. : Juan Anglada Roca, Barcelona, Spain.

FIVE PRIZES of Meccano or Hornby Goods each value 10/6 : H. Denholm, Hobart, Tasmania ; H. Lamb, Capetown, S. Africa ; G. Wilkinson, Durban, S. Africa ; W. Barry, Christchurch, New Zealand ; T. Robson, Amman, Transjordania.

PRIZES of Goods each value 5/– : K. Van Dommelen, Antwerp, Belgium ; F. Hinbest, Toronto, Canada ; H. Brand, Berne, Switzerland ; S. Roy, Assam, India ; M. Lupton, Natal, S. Africa ; J. L. Roch, Cartagena, Spain.

CERTIFICATES OF MERIT : A. Lambeth, Wollongong, Australia ; F. Underdown, Sydney ; H. Baker, Plunkett, Saskatchewan, Canada ; C. Carter, Nixon, Ontario ; J. Cesak, Winnipeg ; A. Keller, Rockglen, Saskatchewan ; H. Shorten, Regina, Saskatchewan ; V. Stewart, Lefroy, Ontario ; W. Thomson, Gladys, Alberta ; B. Kremer, Copenhagen, Denmark ; T. Kwong, Kuala Lumpur, Federated Malay States ; Carl-Erik Lindh, Helsingfors, Finland ; A. W. Boeke, Baarn, Holland ; R. Latimer, Rangoon, Burma ; J. Magri, Valletta, Malta ; C. O'Neil Sommerville, Dargaville, New Zealand ; P. Renbjor, Levanger, Norway ; R. Rasmussen, Bergen ; E. Paasche, Bergen ; P. Haaland, Bergen ; D. Burne, Durban, S. Africa ; R. Cain, Durban ; J. Carter, Capetown ; T. Lowe, Krugersdorp, Transvaal ; J. Mauerberger, Capetown ; G. Ross, Malvern ; C. Dalvit, Buenos Aires ; R. Raschle, Wattwil, Switzerland.



A realistic model of a tank ship, by H. Lee, Ardrossan.

The First and Second Prizes were awarded for model locomotives, and the splendid constructional work that appears in each of these models compensates for the commonplace nature of the subject. The First Prize model represents a C.P.R. locomotive, and is built to a scale of $\frac{3}{4}$ in. to one foot. The boiler is 6 in. in diameter, and is fitted with safety valves, whistle and bell. The cab is of the short vestibule type, and is complete with all the essential fittings, such as pressure and water gauges and throttle control. The tender is carried on two six-wheeled bogies.

Pablo Giese chose a Hudson type locomotive of the New York Central Lines as the prototype for his model, which he constructed with the aid of illustrations in the *"M.M."*

An entry of more than usual interest is a fine calendar clock, designed and constructed by Juan Anglada Roca. The clock has three hands that designate the hours, minutes and seconds respectively, and striking gear that records the quarter hours and hours on two different toned bells. Although this part of the clock is beautifully built, the finest work is done in the calendar portion. Three openings are provided in the front of the clock case, in which appear the days of the week, date of the month, and the name of the month. The model is a splendid example of originality in choice of subject and no doubt will encourage other constructors to build similar models themselves.

Another fine model represents a Priestman excavator and was sent in by G. Wilkinson. The hoisting and dragging operations are worked from separate winding drums, and each movement can be brought into operation simply by manipulating a lever. The cab consists of a framework of Angle Girders covered with Flat Plates, and is fixed to a platform that is mounted on creeper travelling tracks.

"Christmas" Contest (Home Sections)

As the "Christmas" Contest was announced in the December 1933 issue of the *"M.M."* when the winter model-building activities were at their height, the entries received are of more than usual interest. The lucky recipients of the prizes offered for the best models submitted are as follows :

Section A (for Home competitors over 14)

FIRST PRIZE, Meccano or Hornby Goods value £3-3s. : T. Kennett, Sheerness. SECOND PRIZE, Goods value £2-2s. : W. J. Cleland, Peebles. THIRD PRIZE, Goods value £1-1s. : A. Bawden, Croydon, Surrey.

FIVE PRIZES of Meccano or Hornby Goods each value 10/– : M. Birch, Smethwick, Staffs. ; S. Brown, Worcester Park, Surrey ; H. Cotter, Cork, I.F.S. ; H. Lee, Ardrossan ; H. Stephenson, Huyton.

FIVE PRIZES of Meccano or Hornby Goods each value 5/– : R. Adams, Bristol ; J. Barker, Sawbridgeworth, Herts. ; R. Biss, Midsomer Norton, Somerset ; E. Smith, Gillingham ; R. Tydeman, Stowmarket.

Section B (for Home competitors under 14)

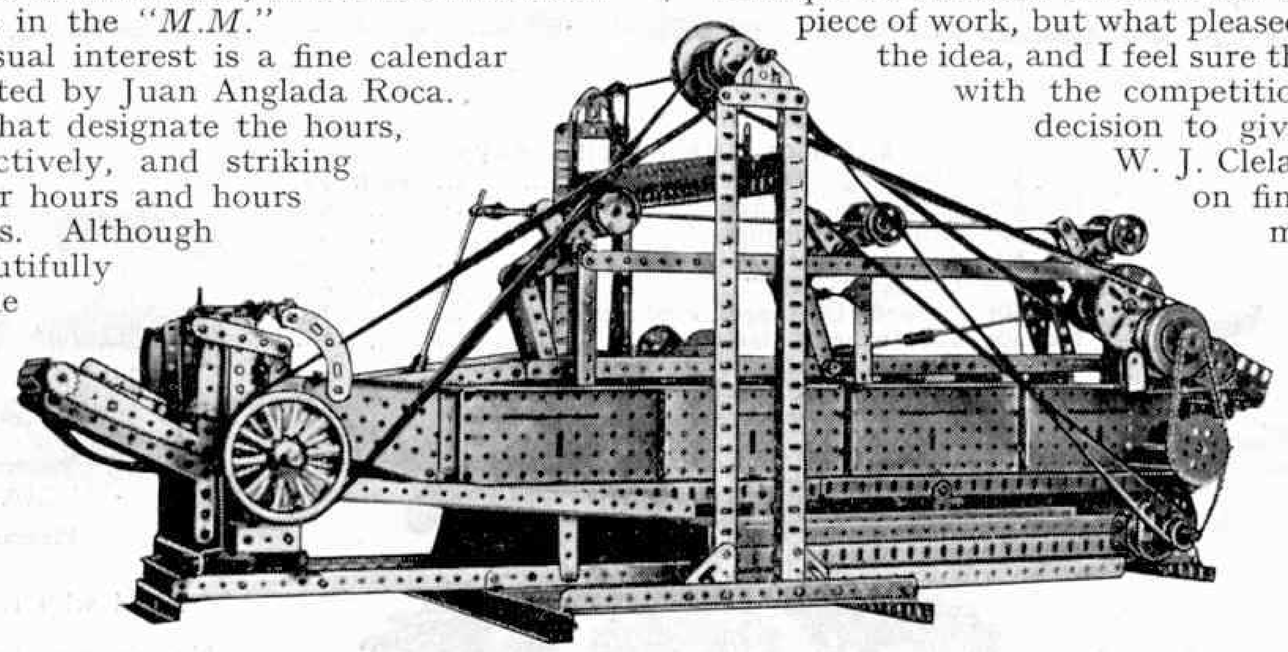
FIRST PRIZE, Meccano or Hornby Goods value £3-3s. : E. Brett-Harris, Weston-super-Mare. SECOND PRIZE, Goods value £2-2s. : J. Scowcroft, Cleveleys. THIRD PRIZE, Goods value £1-1s. : R. Wheeler, Purley, Surrey.

FIVE PRIZES of Meccano or Hornby Goods each value 10/– : T. Browne, Derry ; B. Garwood, Lowestoft, Suffolk ; B. Moses, Birkenhead ; J. Newton, Pontefract ; P. Stern, Dartmouth.

FIVE PRIZES of Meccano or Hornby Goods each value 5/– : C. Ayles, Irvine, Scotland; E. Bloor, Stoke-on-Trent ; R. Hutchings, Westcliff-on-Sea ; A. Jennings, London, S.W.8 ; J. Oram, Devizes, Wilts.

I could fill several pages with descriptions of the wonderful models entered in this Contest, but unfortunately the space at my disposal this month is very limited, and I can make only a brief reference to one or two of the chief prize models. I should like all Meccanoites to see the fine effort that won a First Prize for T. Kennett, as it is one of the best models that I have examined recently. The model represents a marine reciprocating engine and two Lancashire type boilers incorporated in the hull of a vessel. Unfortunately the photographs available are unsuitable for reproduction, otherwise I would have illustrated the model here. As an example of Meccano construction the entire model is a very good piece of work, but what pleased me most was the originality of the idea, and I feel sure this feature counted considerably with the competition judges in influencing their decision to give the model First Prize.

W. J. Cleland also deserves congratulation on finding an original subject. His model is a self-cleansing wool scouring plant, of the type installed in up-to-date mills, and the illustration on this page will give readers an idea of its chief constructional details. The action of the machine is very fascinating, and I am sorry that space does not permit me to describe it.



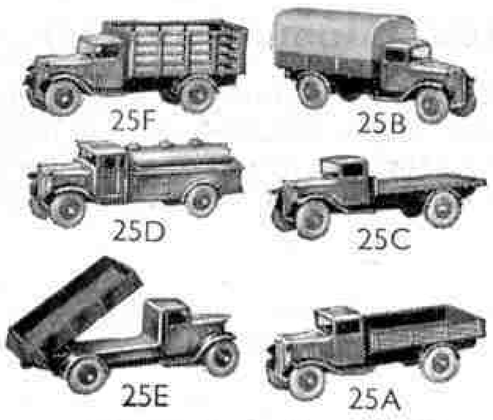
An interesting model of a wool-scouring plant of the type used in mills, by W. J. Cleland, Peebles.

A model airship, 5 ft. 6 in. in length, was sent by A. Bawden, and the First and Second Prize models in Section B are an articulated motor lorry and a ship respectively.

I wish to pass a few words of encouragement and congratulation to Henry Lee, who built the very realistic model of a small Russian tank ship that is illustrated on this page. The model is remarkably life-like and very neatly built, and the only fault that I have to find with it is that non-Meccano parts are used for the life-boats.

MECCANO
DINKY TOYS

Meccano Dinky Toys are rapidly establishing themselves as firm favourites with boys and girls. They are in big demand because they are the most realistic and the most attractive models in miniature ever produced. New items are constantly being added to the series to increase the fun and fascination. One of the latest of these is No. 50, comprising a fine selection of Ships of the British Navy. Then there are Aeroplanes, Train Sets, Motor Cars, Motor Vans, Railwaymen, a fine Racing Car and many others. These splendid toys may be purchased either separately or in complete sets, at the prices shown. Ask your dealer to show you the full range.



Meccano Dinky Toys No. 25

COMMERCIAL MOTOR VEHICLES

Fitted with rubber tyres and silver plated radiators.

No. 25a	Wagon	each	9d.
No. 25b	Covered Van	,,	9d.
No. 25c	Flat Truck	,,	9d.
No. 25d	Petrol Tank Wagon ...	,,	9d.
No. 25e	Tipping Wagon ...	,,	9d.
No. 25f	Market Gardener's Van	,,	9d.

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DELIVERY VANS

Manchester Guardian Van	each	6d.
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Hornby Train Van	,,	6d.
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Oxo Van	,,	6d.
Ensign Cameras' Van	,,	6d.

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Meccano Dinky Toys No. 28/2

DELIVERY VANS

Kodak Cameras' Van	each	6d.
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Crawford's Biscuit Van...	,,	6d.
Wakefield's Oil Van	,,	6d.
Marsh and Baxter's Sausage Van ...	,,	6d.
Meccano Van	,,	6d.

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Meccano Dinky Toys No. 18

GOODS TRAIN SET

No. 21a	Tank Locomotive	each	9d.
No. 21b	Wagons	,,	4d.

Price of complete set 1/9

Meccano Dinky Toys No. 17

PASSENGER TRAIN SET

No. 17a	Locomotive ...	each	9d.
No. 17b	Tender	,,	5d.
No. 20a	Coach	,,	7d.
No. 20b	Guard's Van ...	,,	7d.

Price of complete set 2/3

Meccano Dinky Toys No. 19

MIXED GOODS TRAIN SET

No. 21a	Tank Locomotive ...	each	9d.
No. 21b	Wagon	,,	4d.
No. 21d	Petrol Tank Wagon ...	,,	6d.
No. 21e	Lumber Wagon ...	,,	5d.

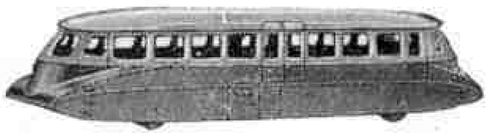
Price of complete set 1/11

Meccano Dinky Toys No. 20

PASSENGER TRAIN SET

No. 21a	Tank Locomotive	each	9d.
No. 20a	Coaches	,,	7d.
No. 20b	Guard's Van	,,	7d.

Price of complete set 2/6



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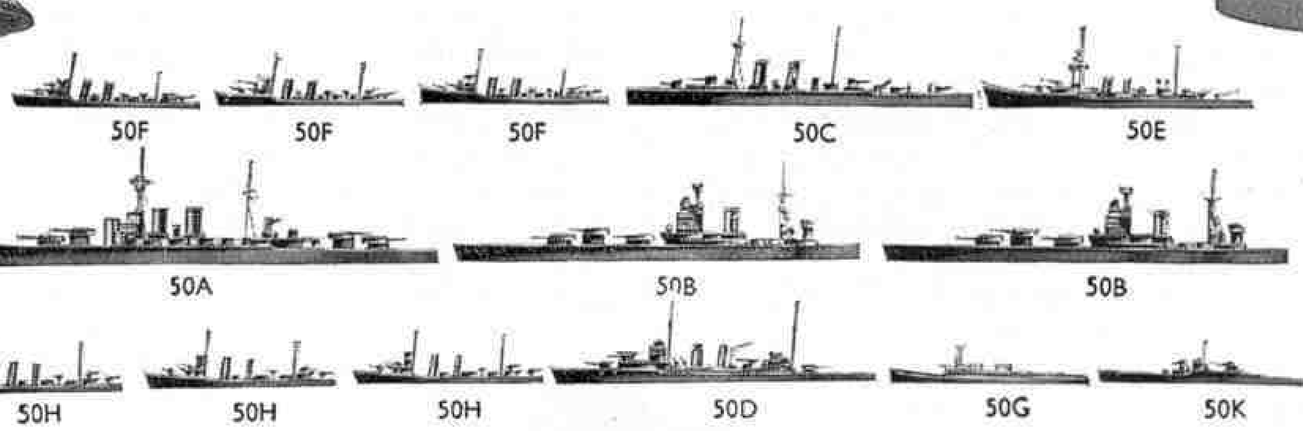

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No. 50a	Battleship "Hood"	each	9d.
No. 50b	Battleship "Nelson"	,,	6d.
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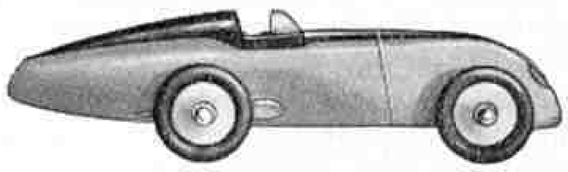
No. 50e	Cruiser "Delhi"	,,	4d.
No. 50f	Torpedo Destroyer, Broke class ...	,,	1d.
No. 50g	Submarine, X class	,,	1d.
No. 50h	Torpedo Destroyer, Amazon class ...	,,	1d.
No. 50k	Submarine, K class	,,	1d.

Price of complete set 3/6



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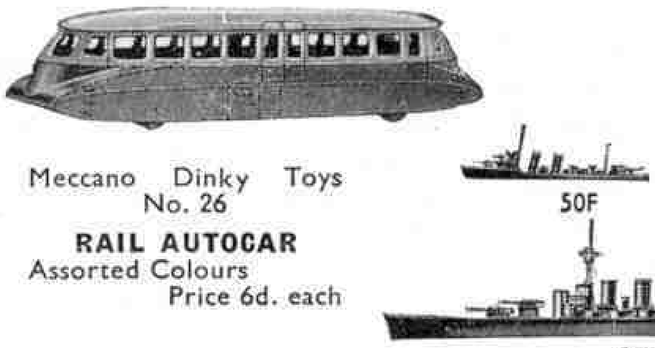


Meccano Dinky Toys No. 60

AEROPLANES

No. 60a	Imperial Airways Liner	each	9d.
No. 60b	Leopard Moth	,,	6d.
No. 60c	Percival "Gull" ...	,,	6d.
No. 60d	Low Wing Monoplane ...	,,	6d.
No. 60e	Monospar Monoplane ...	,,	7d.
No. 60f	Cierva Autogiro ...	,,	6d.

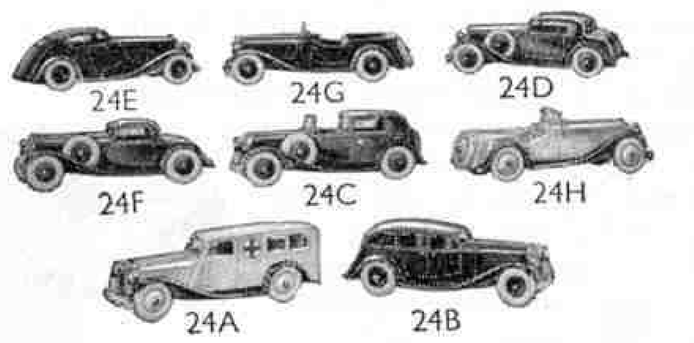
Price of complete set 3/–

Meccano Dinky Toys No. 22

MOTOR VEHICLES

No. 22a	Sports Car	each 6d.	No. 22d	Delivery Van	each 6d.
No. 22b	Sports Coupé	,, 6d.	No. 22e	Tractor ...	,, 9d.
No. 22c	Motor Truck	,, 6d.	No. 22f	Tank ...	,, 1/–

Price of complete set 3/9



Meccano Dinky Toys No. 24

MOTOR CARS

Fitted with rubber tyres and silver plated radiators

No. 24a	Ambulance	each	9d.
No. 24b	Limousine	,,	9d.
No. 24c	Town Sedan	,,	1/–
No. 24d	Vogue Saloon...	,,	9d.
No. 24e	Super Streamline Saloon ...	,,	9d.
No. 24f	Sportsman's Coupé (2 seater)	,,	9d.
No. 24g	Sports Tourer (4 seater) ...	,,	1/–
No. 24h	Sports Tourer (2 seater) ...	,,	1/–

Price of complete set 6/6

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Reports of Summer Meetings

The majority of Meccano club meetings are now being held in the open air, where the members are enjoying swimming, cycling, rambling, speed boat racing, or the playing of cricket and other outdoor games. There is no difficulty in finding some healthy and invigorating pursuit to suit every club member, and I hope that in all clubs full advantage is being taken of the opportunities for real fun that the outdoor season brings with it.

The reports that I have already received from the officials of many clubs show that they have done their best to ensure a pleasant summer by devising interesting programmes on the lines I have suggested, and I shall look forward to hearing of similar arrangements from secretaries of other clubs who so far have not informed me of their intentions. It is just as important to forward reports regularly during the outdoor season as it is when only indoor meetings are being held, and accounts of novel and successful summer events help officials and members of new clubs to plan their own programmes and encourage them to persevere when difficulties arise.

I also hope that a larger number of photographs than I have received in previous years will reach me, for I should like to reproduce in these pages more jolly pictures of members in outdoor scenes, in order to show that those who subscribe to the ideals of the Meccano Guild are among the happiest boys in the world.

Rainy Weather Arrangements

In spite of the scanty rainfall of the last few months it is wise to remember that the Sun does not always shine, even on Meccano boys out for a day's pleasure or engaged in any of the games and other pursuits followed during the summer months! Nothing is more disheartening to members of a club than to meet together at an appointed time for a long ramble, or for a game of cricket, and then to find that the weather is too bad to allow the programme to be carried out as arranged.

To bring outdoor proceedings summarily to a stop because of rain would leave members at a loose end, but fortunately it is not necessary to abandon a meeting for this reason. Instead its course may be changed, for there are few clubs that do not retain their club rooms throughout the summer, and good use can be made of them in circumstances of this kind. There may be work to be done, such as re-arranging fittings, or overhauling stock, and the members of some clubs have taken advantage of opportunities of this kind to clean and decorate their room thoroughly. Their zeal is rewarded when the following winter sessions open, for then there is no delay in commencing attractive meetings.

An alternative to work of this kind is to organise impromptu games tournaments or entertainments. Members enter wholeheartedly into any arrangements of this kind, and while they may not derive as much benefit from it as from the actual programme arranged, the substitution will prevent them from feeling completely disappointed. No difficulty is experienced in starting events of this kind when the club room itself is the meeting place for an excursion or ramble. In other cases members should resort to the club room if rainy weather makes outdoor proceedings impossible.

Meccano Club Leaders

No. 73. Mr. R. Croall

Mr. Robert Croall is Leader of St. George's (Edinburgh) M.C., which was affiliated in October, 1928, and has a splendid record of activity. Special interest is taken by members in Model-building competitions and excursions, and visits are exchanged as often as possible with members of other clubs.

Meccano Club That Holds No Meetings

The Correspondence School (Wellington, N.Z.) M.C. is one of the most remarkable organisations connected with the Meccano Guild, for although it is fully affiliated, its members never see each other! They thoroughly enjoy their association with the Meccano hobby, however, and are as keen and enthusiastic as the members of any Meccano club that holds meetings of the usual kind.

The School with which this club is associated is one of the largest in New Zealand, but no classes ever assemble in its class rooms, for its 1,500 pupils live on lonely farms and inland sheep stations in various parts of the country, and the homes of some of them are 600 miles away from the School itself. This was founded in 1922 in order to meet the needs of children in remote districts who could not attend ordinary schools, and has been so successful that in little more than 10 years its staff has increased from one to more than 30, all of whom are busily employed throughout the day in receiving worked-out lessons from their distant pupils, most of whom they never see, and in planning and despatching new lessons.

The social activities of a School are not forgotten in this unique organisation. The Meccano club is one of the most popular of the societies connected with it, and there was great enthusiasm in many remote quarters of New Zealand when affiliation was granted. The club's Certificate is prominently displayed in the School and arouses the keen interest of pupils who visit headquarters, while a reproduction in "*The Postman*," the School magazine, has given less fortunate members an idea of its appearance.

Naturally the Correspondence School M.C. cannot hold meetings in a club room. Instead, members keep in touch with their Leader by correspondence, and the models they build are entered in special Model-building Contests that are run on the lines of those announced in the "*M.M.*," drawings, photographs and full descriptions of the entries being forwarded to the judges. In addition, there is in operation in the School an interesting scheme for circulating copies of the "*Meccano Magazine*."

The Headmaster of the school, Mr. S. M. Mills, B.A., is President of the Meccano club, and its Leader and organiser is Dr. A. G. Butchers, M.A., senior assistant in the Secondary Department of the school. Mr. C. M. Haybittle, whose portrait was included in the group photograph of the Correspondence School M.C. published last month, is the Secretary of the "*Meccano Magazine*" Circle.

Proposed Clubs

Attempts are being made to form Meccano Clubs in the following places, and boys interested should communicate with the promoters, whose names and addresses are given below:

CULLEN—A. Findlay, The Square, Cullen.
GATESHEAD—F. McFall, 125, Church Road, Low Fell.
GROVE—S. Withers, Hines Lane, Grove, Nr. Wantage, Berks.
GUERNSEY—C. K. Frossard, St. Sampson's Rectory.
HAINE—K. Beeson, "Rosemary," Margate Road, Haine, Nr. Ramsgate.
HULL—George Leak, 10, Bainton Grove, Inglemire Lane.

WRITING PADS
FOR MECCANO BOYS

These Writing Pads are very popular with Meccano boys as is shown by the large number of letters we receive each day written on the familiar tinted paper.

The Pads are supplied in two sizes, each consisting of 50 sheets and cover.

Prices—Large Size 1/– each (post free). Small Size 6d. each (post free).

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Special envelopes, appropriately printed and matching the writing paper in colour, are also available. These are suitable for both the large and the small sheets of writing paper.

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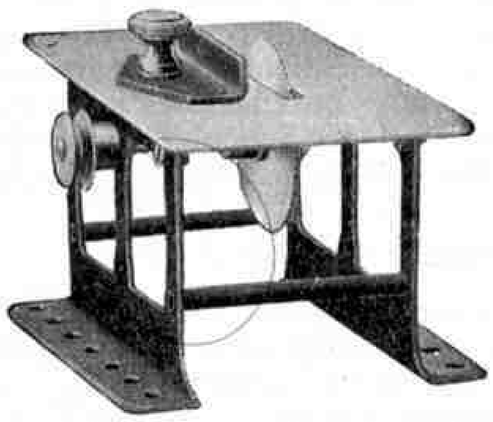
Stands for HORNBY SPEED AND RACING BOATS

Every owner of a Hornby Speed or Racing Boat who prides himself on taking care of his model should obtain a Hornby Boat Stand on which to place his boat when it is not in use. The Stands are available in the following sizes : No. 1 for No. 1 Speed Boats ; No. 1R for No. 1 Racer ; No. 2 for No. 2 Speed Boat and No. 2 Racer ; No. 3 for Nos. 3, 4 and 5 Speed Boats and No. 3 Racer. They can be obtained from any Meccano dealer price 9d. each (any size).

MECCANO LTD., BINNS RD., LIVERPOOL 13.

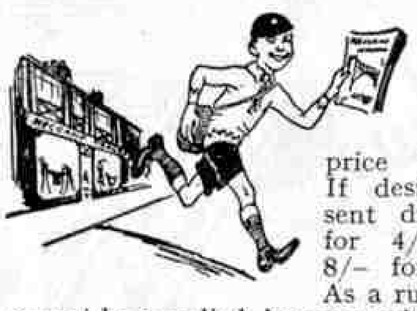
MECCANO SAW BENCH



This model Saw Bench is suitable for use with an Electric or Clockwork Motor or Steam Engine. By means of the equidistant holes in the base it may be built into a Meccano Model Workshop. Beautifully finished in black enamel and nickel. Price 4/–.

Meccano Ltd., Binns Road, Liverpool 13.

How to obtain the "M.M."

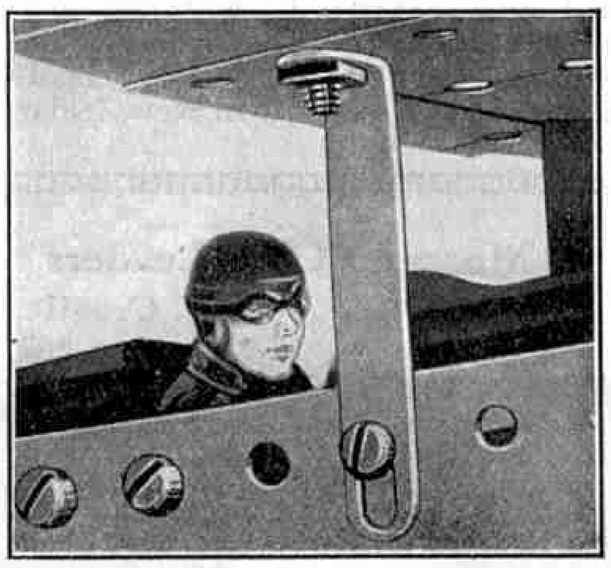


The *"M.M."* may be ordered from all Meccano dealers, or from any newsagent or bookstall, price 6d. per copy. If desired it will be sent direct, post free, for 4/– for six, or 8/– for twelve issues. As a rule back numbers cannot be supplied, because only sufficient copies are printed to fill standing orders. To prevent disappointment, therefore, place a regular order with your dealer, newsagent, or the publishers—

" Meccano Magazine," Binns Road, Liverpool 13.

Miniature Aeroplane Pilots

Aeroplane Parts Nos. P99 and P100



Miniature Pilots are now available for fitting to all open cockpit machines built with the Nos. O, 1 and 2, and 1 and 2 Special, Meccano Aeroplane Constructor Outfits. These attractive little figures, which add a wonderful touch of realism, can be obtained in three different styles—with green coat and orange cap, blue coat and red cap, or red coat and green cap.

Aero Part No. P99, which is suitable for fitting to the No. O Outfit models, is fixed to a special bracket that takes the place of the Propeller Shaft Bracket in the Outfit. The special bracket is secured by passing bolts through the sides of the fuselage into the threaded holes in the bracket. The Propeller Shaft rests in the bearing socket formed in the Pilot's body.

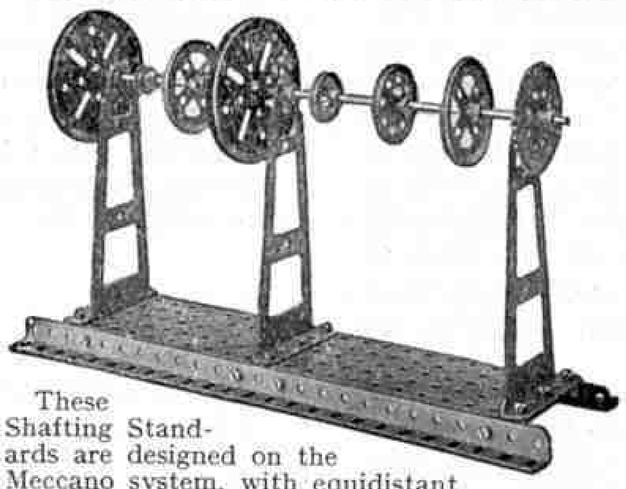
Part No. P100 (illustrated above) is used in Nos. 1 and 2, and 1 Special and 2 Special Outfit models. The Pilot is fixed to a double angle bracket ready for bolting to the sides of the fuselage.

Prices :

P99	Aeroplane Pilot	...	...	...	each	5d.
P100	" "	...	...	...	"	5d.

Meccano Ltd., Binns Road, Liverpool 13

MECCANO SHAFTING STANDARDS



These Shafting Standards are designed on the Meccano system, with equidistant holes. Our illustration shows how strong and serviceable shafting may be constructed from Meccano parts with the aid of the Large Standard.

Standard only, Large (Part No. 177) Price 1/–
" " Small (" " 178) " 8d.

Meccano Ltd., Binns Road, Liverpool 13.

H.R.C. WRITING PADS

Every member of the Hornby Railway Company should make a point of using the special H.R.C. writing paper for correspondence with his friends and with Headquarters. It is available in two sizes and is supplied in pads, each consisting of 50 sheets of superfine buff paper, and cover.

Prices, Large Size 1/– each (post free). Small Size 6d. each (post free).

ENVELOPES

Special envelopes, attractively printed and matching the writing paper in colour. are also available. These are suitable for both the large and the small sheets of writing paper.

Price, per packet of 50, 8d. post free.

Small Size Price 6d. (Post free)

Large Size Price 1/– (Post free)

Meccano Ltd., Binns Road, Liverpool 13.

BINDING THE *"M.M."*

Binding cases for back numbers of the Magazine may be obtained from Messrs. O. H. Bateman and Co., 23, Hanover Street, Liverpool. These are supplied in two sizes (1) for six copies price 3/3 and (2) for twelve copies price 4/9, post free in each case. The binding cases are supplied in what is known as " Quarter Basil, full cloth "—that is to say three-quarters of the sides are dark crimson cloth and the back and a quarter of the sides are dark crimson leather as shown here. The case is tastefully embossed in gold with the name " Meccano Magazine," and on the back is the name and volume number.

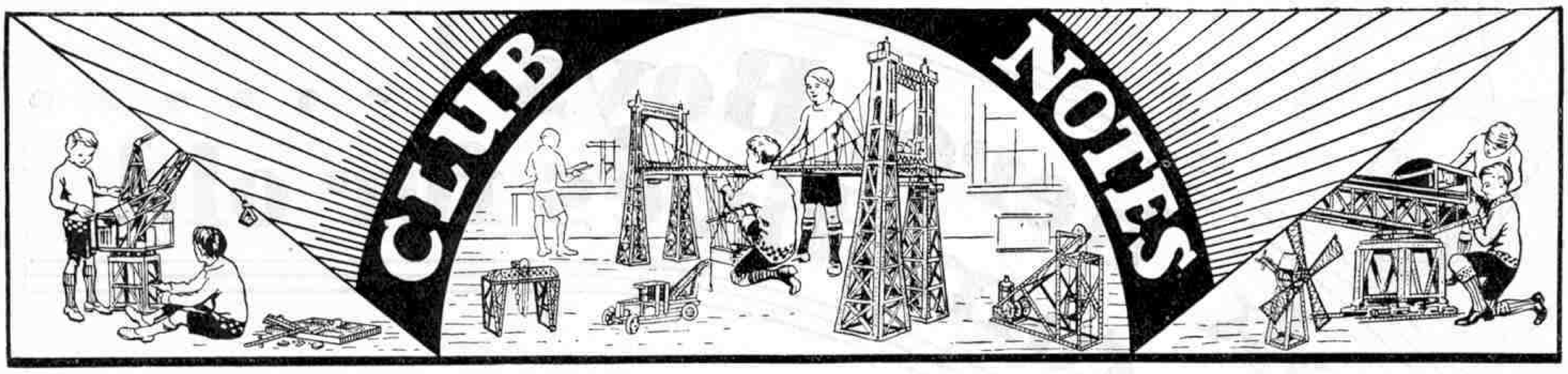
Binding 6 and 12 copies. These binding cases are supplied so that readers may have their Magazines bound locally, but where desired, the firm mentioned above will bind Meccano Magazines at a charge of 5/9 for six issues or 7/6 for twelve issues, including the cost of the binding and also return carriage. The covers of the Magazines may be included or omitted as required, but in the absence of any instructions to the contrary they will be included.

Whilst the binding of the twelve Magazines is quite satisfactory, they form a rather bulky volume and for that reason arrangements have been made to bind six months' Magazines where so desired, as explained above. Back numbers for any volume can be bound and the case will be embossed with the volume number.

MECCANO LUBRICATING OIL

Before commencing to operate a Meccano model, or to run a Hornby Train, all gears and bearings should be oiled thoroughly with Meccano Lubricating Oil. This oil is specially prepared and is of the right consistency for the purpose. Price per bottle 6d.

Meccano Ltd., Binns Road, Liverpool 13.



Colwyn Bay M.C.—Mr. L. Davies has kindly accepted Leadership of the club, and his schemes for stimulating the interest of members have been received with enthusiasm. He has given a series of talks and demonstrations on electrical subjects, including Morse code telegraphy. Long walks also have been arranged, and photographs taken on these occasions have provided practical demonstrations of the principles of photography, which have been dealt with in a lecture by the Leader. Model-building activity continues, and many intricate and original models have been designed by members. An excellent magazine is now being produced, and special arrangements have been made for Lantern Lectures. Club roll: 13. *Secretary:* Mr. L. Davies, "Llys Aled," Woodland Park, Colwyn Bay.

New Bradwell M.C.—The attractive programme of the club is attracting the interest of Meccano enthusiasts, and recruiting continues to be satisfactory. An Exhibition and a Concert are being organised. Interesting Lantern Lectures have been given. A small Billiards Table has been purchased and the game is now very popular. An attractive visit was paid to the L.M.S.R. Carriage and Wagon Works at Wolverton. Club roll: 44. *Secretary:* R. Bellchambers, 29, King Edward Street, New Bradwell, Bletchley, Bucks.

Laindon M.C.—The usual activities have continued, but special interest has been displayed in the club's Hornby Railway. The track has been divided into sections, each under the control of a member, and prizes are being awarded for maintenance and good working. "*The Royal Scot*" was inspected when this famous train visited Southend. Interesting excursions are now being made and a recruiting campaign is being carried on in connection with them. Club roll: 12. *Secretary:* A. G. L. Schofield, "Highfield," Inverness Road, Laindon, Essex.

Becontree M.C.—The club has now been affiliated and is making steady progress. Two Model-building groups have been formed, and a Hornby Train Section has been organised by Mr. W. H. Bond, Leader of the club. One night each month is reserved for Games and Boxing. A Cricket Team has been formed and Rambles and Excursions are held regularly. Club roll: 20. *Secretary:* L. W. Bond, 96, Holgate Road, Dagenham, Essex.

Wednesbury and District M.C.—Model-building Evenings have been varied by Contests, and the best models constructed are displayed in the shop window of Mr. B. Smith, Darlaston, President of the club. Interesting visits arranged have included one to the National Trades Exhibition recently held at Birmingham. Club roll: 10. *Secretary:* A. L. Morgan, 17, Cobden Street, Fallings Heath, Wednesbury.

Old Charlton M.C.—The subjects for Model-building Evenings have included the Tower Bridge, safes, and famous buildings. Charades have been arranged, and talks have been given by members on "*The Making of Bottles*" and "*Metals.*" Other activities have included Debates and a Novelty Evening. Club roll: 21. *Secretary:* B. Stevens, 53, Mount Street, Charlton, London, S.E.7.

Exeter M.C.—Members are showing greater keenness than ever and the models they construct show a good grasp of engineering principles. Lists of new and outstanding models constructed are being prepared monthly, and these now are very extensive. Several members have been awarded prizes in recent "*M.M.*" Model-building Contests. There have been many entries in the newly-formed Cycling Section, and a good programme of runs has been arranged. Club roll: 27. *Secretary:* D. Legg, 25, Chute Street, Exeter.

John Gulson Senior Boys' School M.C.—The outstanding event of the session has been the Exhibition, which was so successful that a larger display of the same kind is now being organised. A Musical Evening has been held, and interesting meetings have been devoted to Model-building Contests based on inventions, and to other interesting activities. Marks are awarded to all models displayed in Contests, and there is keen competition for the prizes to be awarded at the end of the session. In another Contest that is attracting great interest prizes will be awarded for the best booklets or pamphlets on subjects chosen by entrants themselves. Club roll: 17. *Secretary:* H. Ludgate, 46, Fynford Road, Radford, Coventry.

Middlesbrough M.C.—The publicity given in the local press to the club's Exhibition led to the acquisition of eight new members. Meetings are now introduced by short talks on engineering subjects, and in some of these, Mr. J. Senior, Leader of the club, has explained the uses of Meccano Parts. The Hornby Railway Section is now in full activity and other pursuits have included Treasure Hunts, Kim's Game, and Boxing. A successful Parent's Evening has been arranged. Members have given valuable assistance in forming an associated Branch of the H.R.C. and Hornby Locomotive Speed Trials have been held. Club roll: 42. *Secretary:* L. Weighell, 42, Bishopton Road, Grove Hill, Middlesbrough.

Members of the Malvern M.C., Johannesburg, snapped during a cycle run, with Mr. E. Sykes, Leader, on the left. This successful club was formed nearly 15 years ago, and cycle runs, sports meetings, and other activities have helped to develop club spirit. A flourishing girls' section is a special feature of the club.

Bridport Grammar School M.C.—Regular meetings are now being held in the club room, which was not available during the winter session. Members are keen stamp collectors, and the funds of the club have been increased by selling stamps to members and others. Club roll: 33. *Secretary:* H. Dommett, West Allington, Bridport, Dorset.

AUSTRALIA

Marlborough (Mont Albert) M.C.—The club's birthday was celebrated by a Social Evening, the refreshments including a magnificent Birthday Cake. Recent excursions have included a visit to the Box Hill Automatic Telephone Exchange, when the working of the instruments was fully explained to members; and a joint visit with members of the Melbourne M.C. to the Orient liner "*Otranto.*" Club roll: 21. *Secretary:* I. L. Scott, 76, Victoria Crescent, Mont Albert, Victoria, Australia.

NEW ZEALAND

Ashburton M.C.—Parents' Night was a wonderful success. The models included in a special display were judged by the visitors, who appreciated the compliment paid to them in inviting them to select the best. The prizes consisted of vouchers to be exchanged for Meccano Parts at the local dealers. Members of the Christchurch Club who visited Ashburton for this event stayed over the week-end and discussed club topics at friendly meetings. A cup to be awarded annually to the member securing the highest marks in Model-building Contests has been kindly presented by Mr. S. Osborne. *Leader:* Mr. C. H. Taylor, 14, Grey Street, Ashburton, New Zealand.

SOUTH AFRICA

Berea M.C.—Members of the club visited Capetown, where they spent an enjoyable holiday, inspecting Italian submarines then in Table Bay Docks, ascending Table Mountain by the aerial cableway, and visiting other places of interest in Capetown and district. When club meetings were resumed, members worked hard in preparation for the Transvaal Meccano Clubs Union Display at a Fête arranged by the Parktown Boys' High School, Johannesburg. This was very successful, and the models exhibited aroused the keen interest of the Headmaster and members of the staff, and also of the Mayor of Johannesburg, who remarked that Meccano was used in connection with building plans and projects of the Johannesburg Municipality. *Secretary:* C. Blackbeard, 8, Joel Road, Berea, Johannesburg, South Africa.

Malvern M.C.—The programme for the outdoor season included the annual Picnic and other outings. Members went into strict training for the sports of the Transvaal Meccano Clubs Union and were greatly helped by an interesting talk by Mr. C. D. Bulman, who is probaby the oldest active athlete in South Africa. Mr. Bulman kindly offered facilities for practice at his sports grounds. Special attention is now being paid to the Junior Section, which meets regularly for Model-building, senior members encouraging and advising the others. Interesting Debates have been held, and at a specially interesting meeting junior members gave short impromptu talks on their hobbies. A novel "Grumbles Meeting" was arranged, but the only member who had a complaint spoke of the importance of better support for the Leader! *Secretary:* C. D. Slade, P.O. Box 8, Cleveland, Johannesburg, South Africa.

Clubs Not Yet Affiliated

CANADA

Edmonton Y.M.C.A. M.C.—There has been great activity under the direction of Mr. E. Jordan, Leader of the club, and at least one new member has joined every week. Models brought to meetings by members have included Cranes, Elevators and Bridges of all types. It is proposed to establish a Senior Section, the members of which will concentrate on model-building illustrating problems in engineering construction. Meccano boys and others interested should communicate with Mr. C. D. Forsyth, Y.M.C.A., Edmonton.

Ottawa M.C.—Members are chiefly interested in model railway work, and have laid down a complete Hornby Train system that is operated in accordance with modern practice. An efficient block signalling system with unique features has been devised, and new equipment is constantly being added to give further scope to the operations carried out. *Leader:* Mr. Earl Gray, 251, Flora Street, Ottawa, Ontario.

Vancouver Y.M.C.A. M.C.—This newly-formed club is making excellent progress and membership is increasing rapidly. Three groups have been organised in order to enable every member to make the most of his association with other model-building enthusiasts. New members are required, and details may be obtained from Mr. G. A. Ross, Y.M.C.A., Vancouver.

Church of the Epiphany (Toronto) M.C.—This new club was organised as a result of interest aroused by a display by the Meccano Section of the Third Toronto Wolf Cub Pack. Members are enjoying an interesting season, and are particularly keen on Model-building work. *Leader:* Mr. Kelly, Church of the Epiphany, Queen Street and Beatty Avenue, Toronto.

Look here, Boys !..... Locomotives for old

Here is a plan to secure a fine new Hornby Locomotive in exchange for your old one.

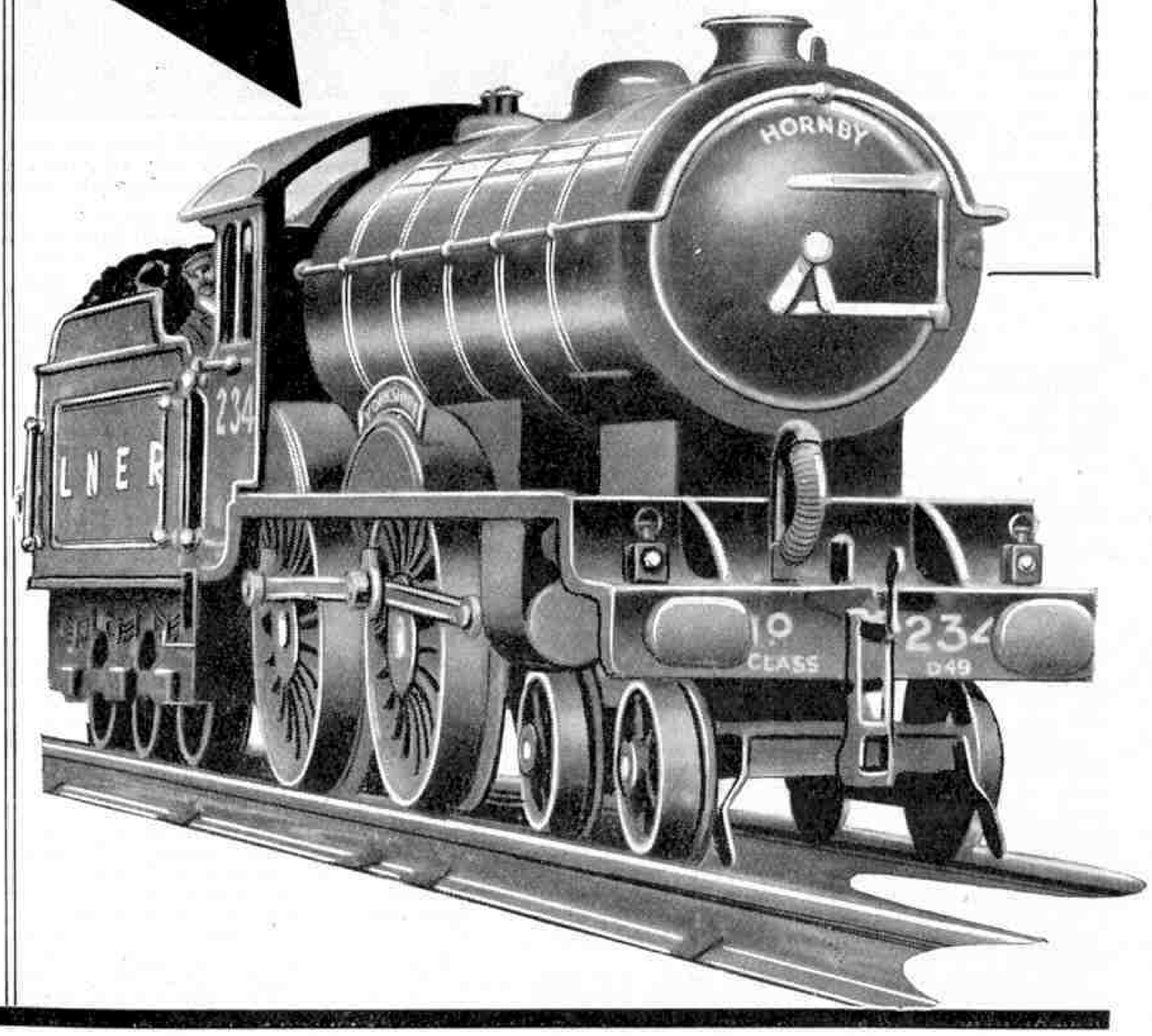
First of all, study carefully the latest Hornby Train Catalogue, and select from it the new up-to-date Hornby Locomotive you want. Then pack up your old Hornby Locomotive and send it to us addressed "Special Service Department," Meccano Ltd., Binns Rd., Liverpool 13. Your order for the new Locomotive and the necessary remittance should be enclosed. You can easily ascertain how much to send by deducting the part exchange allowance indicated in the list given here from the price of the new Locomotive, and adding 1/– for postage on the new model you purchase. It is important to note that the catalogue price of the new Hornby Locomotive you purchase MUST NOT BE LESS THAN DOUBLE THE PART EXCHANGE ALLOWANCE MADE FOR YOUR OLD LOCOMOTIVE.

If you prefer to do so, you can effect the exchange through your dealer, who will be very pleased to give you any further information you require.

EXCHANGE YOUR OLD HORNBY LOCOMOTIVE TO-DAY !

HORNBY TRAINS

BRITISH AND GUARANTEED



Part Exchange Allowances for Hornby Locomotives

CURRENT TYPES

MO Locomotive	1/4
M1/2 Locomotive	2/3
M3 Tank Locomotive	3/9
No. O Locomotive	5/3
No. 1 Tank Locomotive	6/3
No. 1 Locomotive	6/3
LEC 1 Locomotive (Swiss Type)	7/6
No. 1 Special Locomotive	8/3
No. 1 Special Tank Locomotive	8/3
LST M3/20 Tank Locomotive (20-volt)	11/3
No. 2 Special Locomotive	11/3
No. 2 Special Tank Locomotive	11/3
No. 1 Electric Tank Locomotive, Permanent Magnet	12/6
LST 1/20 Tank Locomotive (20-volt)	12/6
LE 1/20 Locomotive (Swiss Type), 20-volt	13/3
LE 2/20 Locomotive (20-volt)	16/6
No. 2 Electric Tank Locomotive	18/9
No. 3E Locomotive	18/9
No. 3E Riviera "Blue" Locomotive	18/9
No. 3C Locomotive	13/9
No. 3C Riviera "Blue" Locomotive	13/9
Metropolitan C Locomotive	11/3
Metropolitan L.V. Locomotive	20/–

OBSOLETE TYPES

M2930 Locomotive	1/–
George V Locomotive (These models were identical)	3/3
No. OO Locomotive (These models were identical)	3/3
M3 Locomotive	4/3
Zulu Locomotive	5/3
Zulu Tank Locomotive	6/3
No. 2 Locomotive	10/–
No. 2 Tank Locomotive	11/3
No. 1 Locomotive, fitted for Hornby Control	7/6
No. 1 Tank Locomotive, fitted for Hornby Control	7/6
No. 2 Locomotive, fitted for Hornby Control	11/3
No. 2 Tank Locomotive, fitted for Hornby Control	12/6
Metropolitan H.V. Locomotive	20/–

MECCANO LTD., Binns Rd., LIVERPOOL 13

Branch Notes

HOLYWELL (OXFORD).—An excellent layout has now been constructed, consisting of a non-continuous double track main line and two branch lines. Colour light signalling controlled from a central switchboard is being fitted up throughout. Excellent goods and passenger services are maintained at track meetings. Interesting talks have been given by Rev. L. A. Garrard on "*Scottish Locomotives*" and "*Locomotives of the Southern Railway.*" Secretary: M. Weatherall, 29, Holywell, Oxford.

ST. SAVIOUR'S (RAYNES PARK).—Regular train services are run at all meetings, special measures being taken to maintain these when track repairs and extensions are in progress. New tunnels, rails and rolling stock are being obtained to enable further extensions to be made, and operations become more realistic at every meeting. Social Evenings and entertainments also have been arranged. Secretary: A. Wakefield, 39, Elm Walk, Raynes Park, S.W.20.

FINCHLEY.—The track has been relaid and considerably extended. It is correctly signalled and trains can now be run to timetable without congestion. Meetings are held on Saturday afternoons and are very enjoyable, a club tea usually bringing proceedings to an end. Secretary: J. Price, "Mancroft," Windsor Road, Finchley, London, N.3.

WHITGIFT SCHOOL.—Practical meetings for track operation have been varied by debates and by special visits to places of railway interest. The most interesting of these was paid to the Old Oak Common Running Sheds of the G.W.R., which was followed by a tour of the Erecting Shop. Secretary: H. J. Kirby, "Minniscot," Riddlesdown Avenue, Purley, Surrey.

CENTENARY (GOOLE).—This newly incorporated Branch has held its first meetings. Stock has been taken of all available material and plans for the Branch layout have been made. Weekly subscriptions have been arranged in order to provide funds for visits to different points of interest on local railways. Secretary: P. Heslehurst, 1, Airmyn Avenue, Centenary Road, Goole, Yorks.

ALFRETON.—At track meetings one group of members operates the trains and another looks after the permanent way, signalling, etc. Strict enquiry is made in the event of any mishap. The track provides fast and slow lines throughout, and members find it fascinating to watch expresses on the fast line overhauling goods and local passenger trains on the slow line. Repairs and extensions are carried out while operations actually are in progress, and warning boards similar to those used on real railways are then placed in position. Speed restrictions imposed on these occasions are always carefully observed. Secretary: A. T. Reid, 5, King Street, Alfreton, Derbys.

A group of members of the Alfreton Branch, No. 254. The Chairman, Mr. J. H. Wetton, is seated in the centre of the group, and on his right is A. T. Reid, secretary. Operations on the Branch track are carried out in a workmanlike manner, and repairs and extensions are put in hand without disturbing the services to a greater extent than in the case of real railways.

HARLESDEN METHODIST. — Operations are conducted regularly on the Branch track, which is continually being improved and extended. Practically the whole of the permanent way material is now laid out on planks, but the track formation is not permanent and is altered from time to time in order to provide variety in working. Meccano Aeroplane and Motor Car Sections are being formed, and recruits interested in these will be welcome. Secretary: J. P. Summers, 11, Radcliffe Avenue, Harlesden.

ILKESTON AND DISTRICT.—The Branch room is now open every evening, and members are booked to attend for track operations on three nights a week. This gives every member excellent opportunities of good practice. A special feature is made of building Meccano Super Models representing various types of locomotives. New members are required and those interested should apply to the secretary for full details. Secretary: F. B. Caddick, "Woodthorpe," Catherine Avenue, Ilkeston, Derbys.

SEFTON.—Members continue to carry out interesting operations on the Branch layout. A Visit to Liverpool Docks and a trip on the Overhead Railway aroused keen interest. Secretary: P. D. Michell, Albany Avenue, Eccleston Park, Prescot.

AUSTRALIA

MELBOURNE.—Mr. L. Ison, Chairman of the Branch, is unable to continue in this position and has been succeeded by Mr. L. J. Fletcher. Regular meetings on the usual lines have been continued and interesting excursions have been arranged, including visits to local Hobbies and Model Railway Exhibitions. Members are now looking forward to interesting events in connection with the forthcoming Melbourne Centenary Celebrations. Chairman and Secretary: L. J. Fletcher, 66, Davies Street, Moreland, N. 10, Victoria, Australia.

Proposed Branches

The following new Branches of the Hornby Railway Company are at present in process of formation and any boys who are interested and desirous of linking up with this unique organisation should communicate with the promoters whose names and addresses are given here. All owners of Hornby Trains or accessories are eligible for membership and the various secretaries will be pleased to extend a warm welcome to all who send in their applications:

AYR—H. B. Allan, 29, Bellevue Crescent, Ayr.

CANADA—Mr. Henry J. Nye, 66, Gray Avenue, Mt. Dennis, Toronto.

LONDON—M. Comar, 95, Middlesex Street, E.1.

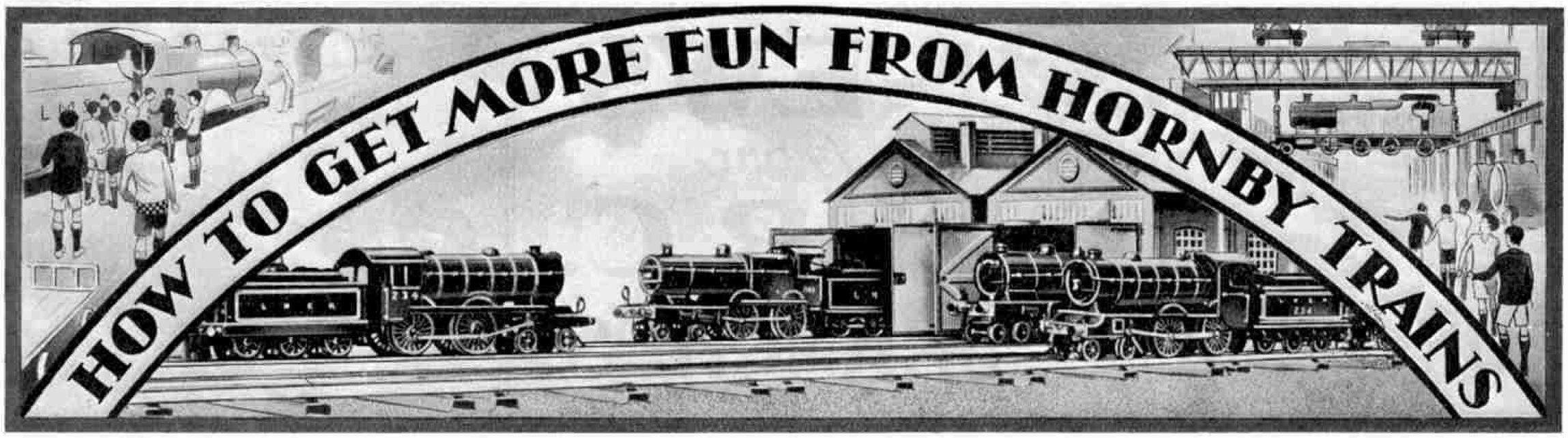
LONDON—A. Mills, 51, Whitburn Road, Lewisham, S.E.13.

LONDON—S. D. Newman, 66, Crouch End Hill, Crouch End, N.8.

LONDON—L. E. Ware, 20, Elspeth Road, Clapham Common, S.W.11.

MITCHAM—N. C. Taylor, "Devonia," Cedars Avenue, Mitcham, Surrey.

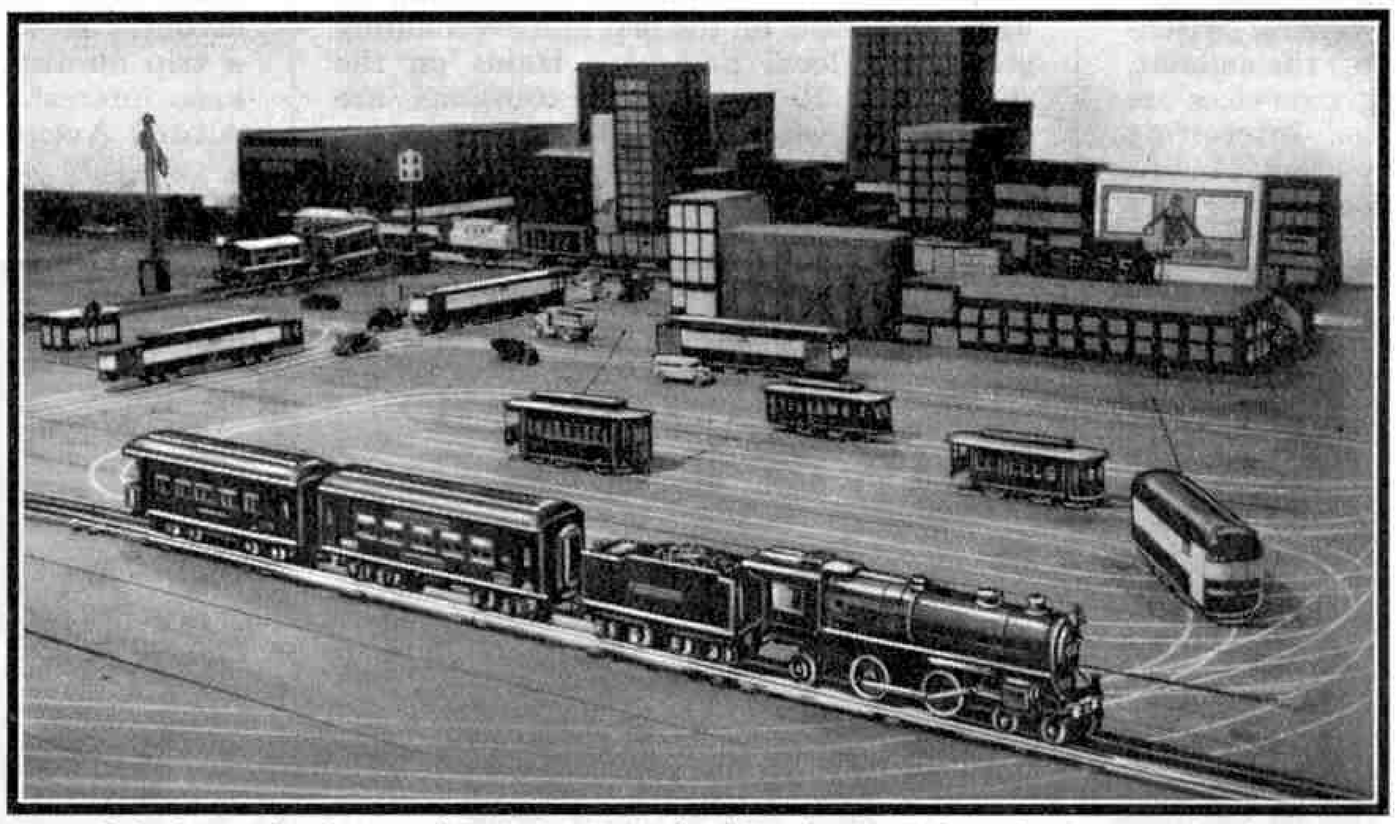
NEWCASTLE-ON-TYNE—C. J. Fairham, 14, Welford Avenue, Coxlodge, Gosforth.



LXVIII.—AMERICAN HORNBY TRAINS

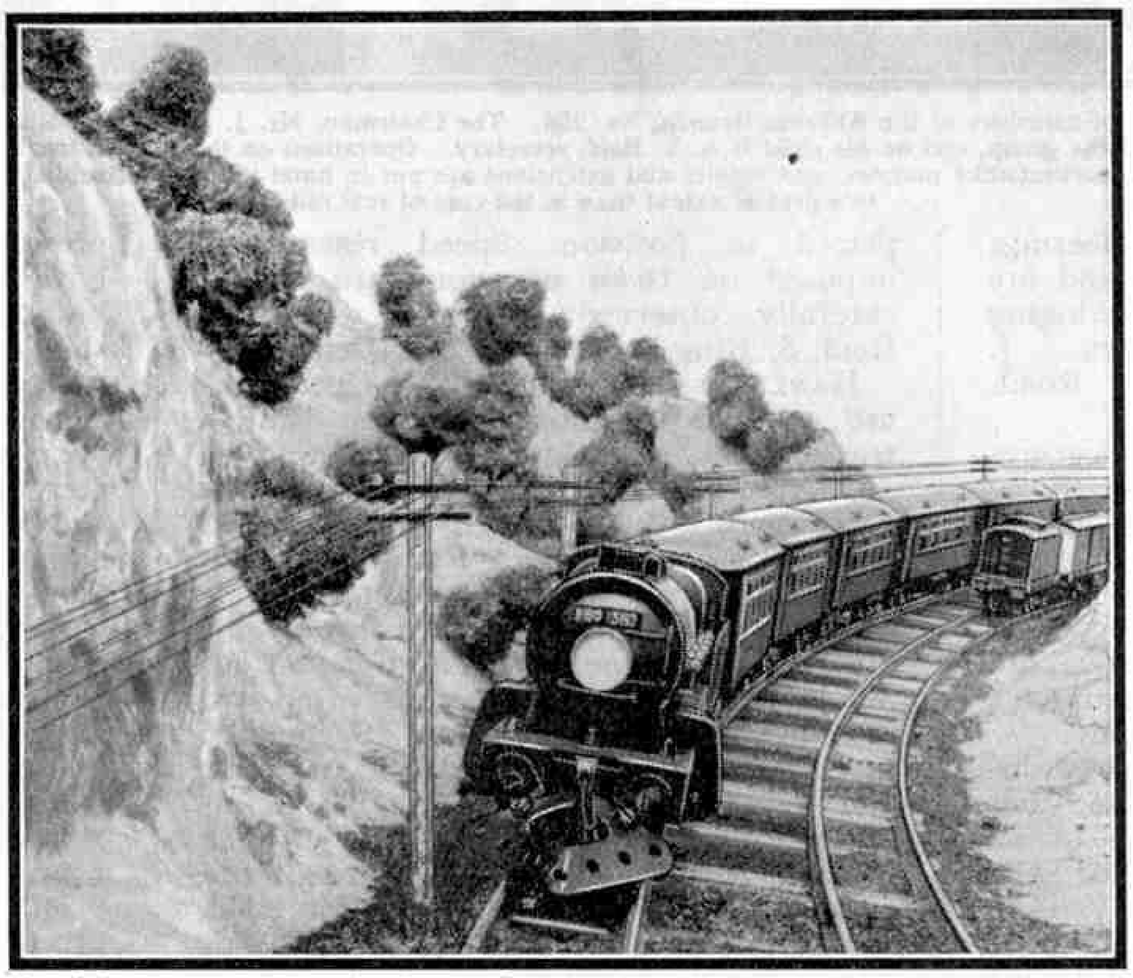
IN the January and February issues of the "*M.M.*" last year we dealt with various suggestions regarding the reproduction of American railway conditions on Hornby layouts. In addition to the Hornby American type rolling stock, standard vehicles of the Series were made use of, the only modifications suggested being applied to the Riviera "Blue" Locomotive. These modifications were necessary in view of the absence of an actual American locomotive from the Hornby range, and the Riviera "Blue" locomotive was selected on account of its foreign outline generally, its stove-pipe chimney and sand "dome" on the boiler barrel, and its large bogie tender. Readers should refer to page 61 of the January 1933 issue for complete details.

The interest aroused by these articles was considerable, and many readers have since suggested that we should return to the subject again in due course. It is only natural that the inclusion of certain typical items of American rolling stock in the Hornby series should cause those enthusiasts who possess them to consider suitable ways and means for their correct employment, either independently or in conjunction with certain suitable items of English, or perhaps Continental, rolling stock of the Hornby range. We propose therefore to deal with the various characteristics of American railways and their operation, and to suggest schemes for their reproduction in miniature on Hornby layouts.



Part of the interesting layout of R. V. Mehlenbeck of Peoria, Ill., U.S.A. Special attention is given to lineside effects in which the buildings and street car system are prominent features.

The extent of the American continent makes it a land of great distances, so that long through journeys are commonly made between important centres hundreds of miles apart. A continuous main line is therefore practically a necessity on a miniature layout. The varied features of the American landscape as seen from the train provide plenty of scope for those who give special attention to scenic effects. American town or city scenery is characteristic, and some idea of the possibilities in this direction is given by the upper photograph on this page where various city blocks and skyscrapers are shown as part of the layout.

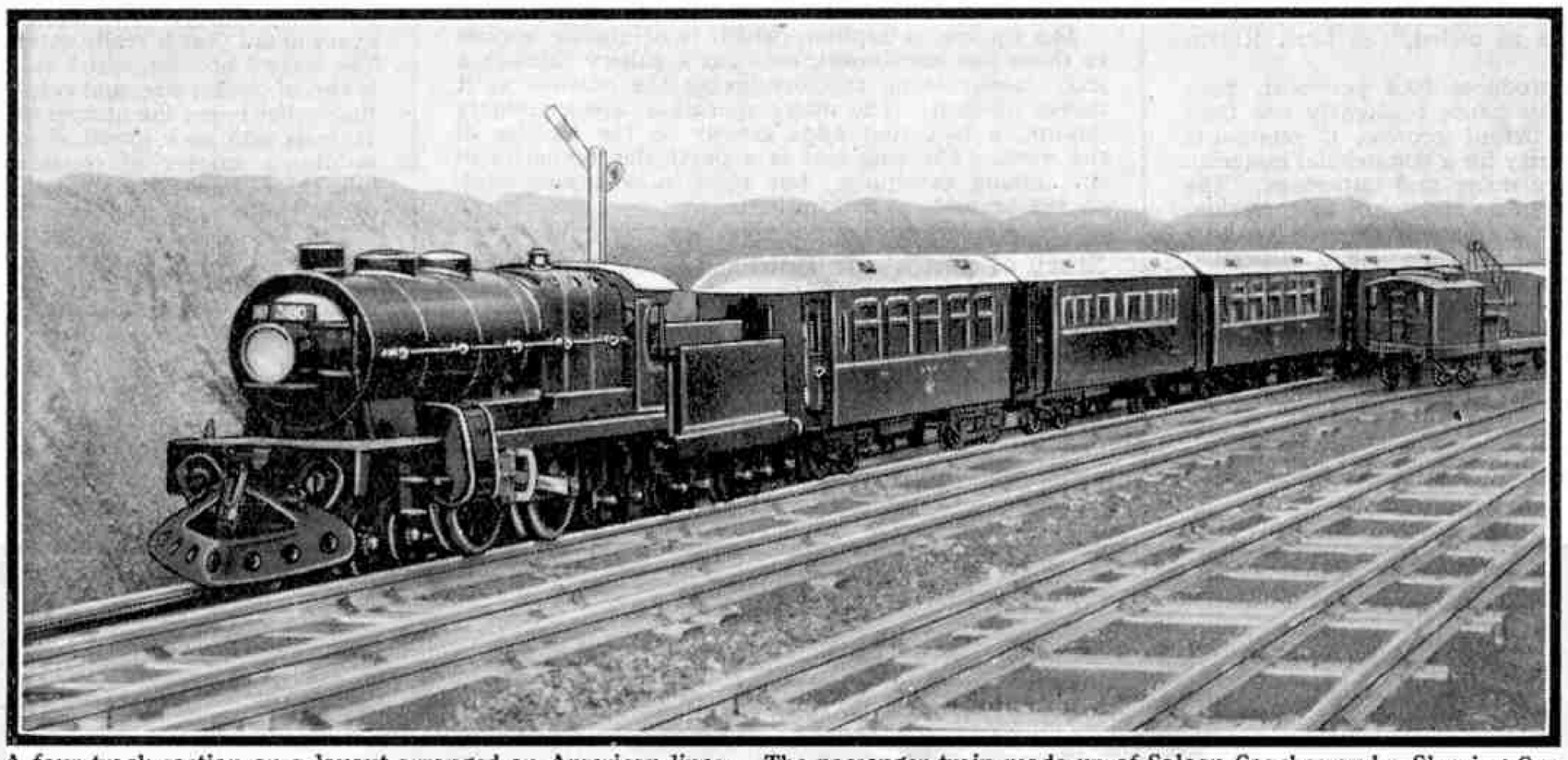


A miniature express running on the right-hand track as in American practice. The locomotive is a Hornby Riviera "Blue" engine modified to represent an American prototype, as referred to in this article.

As regards the actual track, the long stretches of single line that are frequently found in miniature, owing to the necessity of making available rails go as far as possible, will be quite in accordance with actual practice. American lines in the more remote parts are extremely simple in their equipment. The terminals and yards in big cities are very extensive, but for miniature railway purposes our American layout can be held to represent a complete division that does not incorporate any really big city. Simplification of detail will therefore be in accordance with actual conditions.

While dealing with tracks, a point to be remembered is

that where separate lines are available for trains in each direction, right-hand running is the rule, in direct contrast to the British practice of keeping to the left. Left-hand crossover points that are normally trailing points on English layouts become facing points where American practice is followed. Further, signals are placed on the right-hand side of the track to which they apply, and are therefore arranged with their semaphores the reverse way to those in this country ; that is, pointing to the right away from the track when seen from the engine. It is thus not possible to employ Hornby Signals in the ordinary manner for American type layouts, but the M Series signals may be modified and used as upper-quadrant signals. This effect is gained by turning the semaphore over from its normal position so that it points to the right of the track as in the upper photograph on this page.

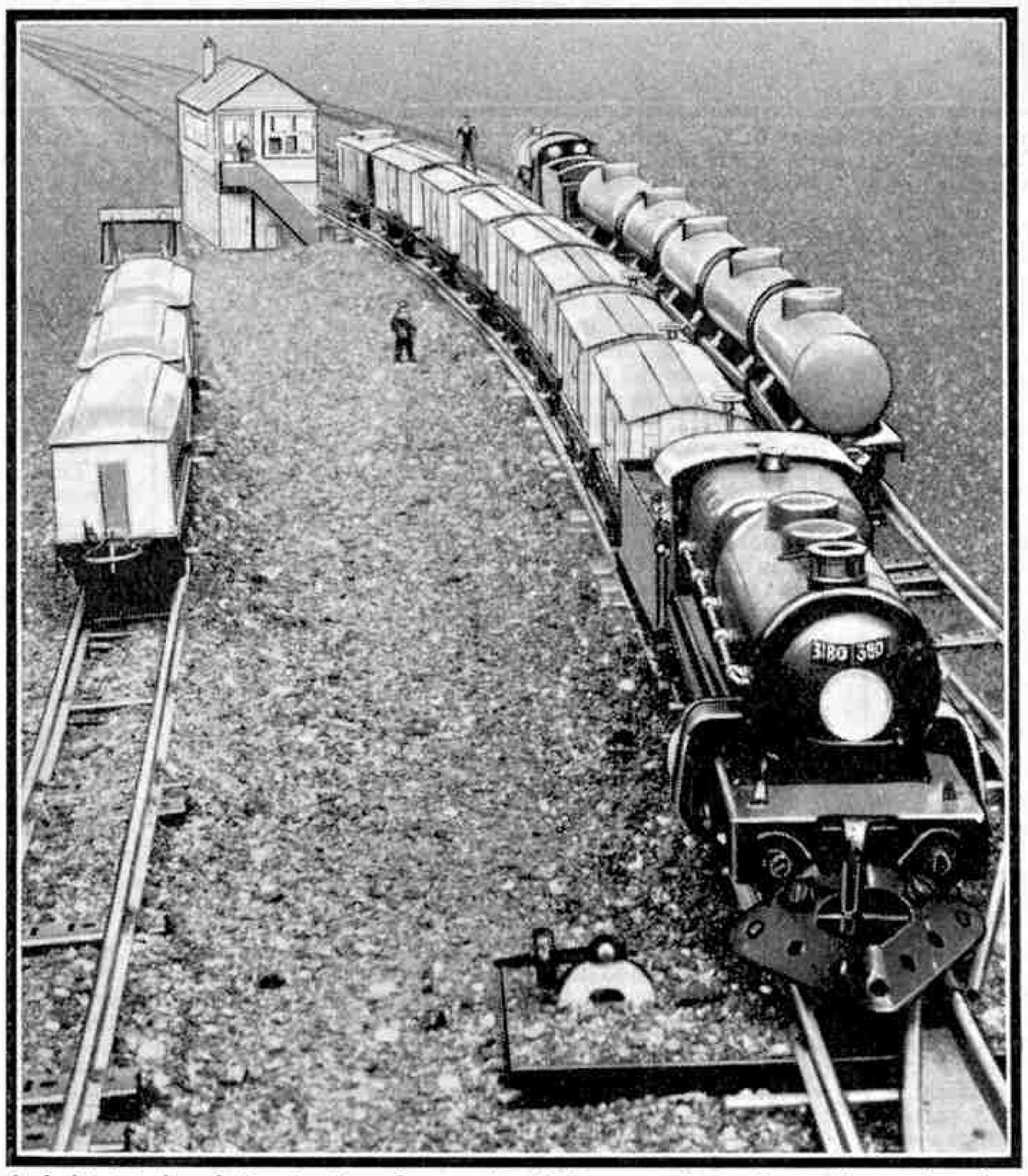


A four-track section on a layout arranged on American lines. The passenger train made up of Saloon Coaches and a Sleeping Car is passing a breakdown train travelling in the opposite direction.

As regards passenger rolling stock, the American type Pullmans that are available in the Hornby Series are finished in either yellow or green, and each vehicle may be obtained named either "Washington" or "Madison." These cars are four wheelers, and although of small proportions they are quite representative of American coach-building practice in their general contour.

If larger bogie vehicles are preferred, the standard No. 2 Saloon Coaches of the Hornby series may be used either in L.M.S.R. or L.N.E.R. colours. Both these Coaches are of the centre-corridor pattern with end vestibules, which makes them suitable for the purpose. The upper photograph on this page previously referred to shows a train made up in this way, but additional interest is lent by the inclusion in the train of one of the familiar Riviera "Blue" Sleeping Cars. The outlines and general construction of this vehicle, with its relatively small windows and straight sides, are similar to those of American stock.

Turning to Hornby American freight rolling stock, a typical example is the Box Car. This is representative of a type of vehicle that in its various forms is commonly used in the U.S.A. and Canada for all kinds of traffic. It is finished to represent the vertical boarded construction usual for these cars, and has a sliding door on each side. Several ladders are shown reaching to the roof, and complete information regarding the equipment and dimensions of the car appears prominently on each side. This is necessary owing to the large numbers of these cars that are in use and the remarkable extent of their journeys all over the continent, in the course of which they are transferred from one system to another. The couplers, brake gear and other fittings therefore have to conform to certain standards, hence the details regarding them that appear on the sides of the Hornby Box Car.



A freight train of Hornby Box Cars and a Caboose ready to leave the yard. On adjacent tracks there are Hornby American Pullman Cars and Tank Cars.

The peaked roof is a typical American feature, as also is the footway or "deck" in the centre of it. This is for the use of train or yard men who have to make their way along the roof when the car is on the run in order to manipulate the brake wheel that is fitted on a vertical column at one end. A miniature brake wheel is a prominent fitting on the Hornby Box Car.

The Tank Car is another effective model, and like the Box Car it carries details as to equipment and capacity. Trains composed exclusively of Tank Cars cover long distances in conveying oil from the refineries to the distributors. The Hornby vehicle reproduces very well the characteristics of the American tank car, and is finished to represent one of the fleet of the Union Tank Car Company, a firm that operates large numbers of cars.

The caboose, which corresponds to the English goods brake van, is necessary to complete any freight train. The Hornby Caboose is provided with observation platforms at each end and has on its roof the raised cupola for look-out purposes.

The Story of Nickel—(*Continued from page 457*)

successive descents through the decomposer are clearly seen in somewhat the same way as the rings showing annual growth are visible in cross-sections of tree trunks.

The carbon monoxide is led away from each section to a collecting tube from which it is returned by blowers "to give wings to nickel," as Lord Kelvin described it.

The Mond process produces 99.8 per cent. pure nickel, and although this figure is slightly less than that obtained by the Orford process, it represents a very high degree of purity for a commercial material.

The uses of nickel are many and important. The pure metal, on account of its resistance to corrosion, is of great value for the manufacture of cooking utensils and for coinage; while when deposited electrolytically upon metals that are liable to tarnish it provides them with a highly protective covering. In addition it is invaluable for alloying with steel, and with non-ferrous metals such as copper, zinc, and chromium.

The addition of quite a small percentage of nickel confers upon steel an increase in strength and toughness, at the same time rendering it more ductile and less liable to corrosion. On this account nickel steel is very widely used for such purposes as making the blades of steam turbines. The remarkable increase in tensile strength due to the presence of such proportions as from 3 to 3½ per cent. of nickel has been taken advantage of by structural engineers, who have used this grade of nickel steel extensively in the building of large span bridges.

In nickel-chromium steel the strengthening effect of the nickel is further enhanced by the inclusion of a small percentage of the rare metal chromium. These remarkable alloys are specially suitable for machinery that is liable to sudden shock or very hard wear, and on that account they have been largely used in making armour plate and armour-piercing projectiles. For the same reasons we find these alloys used extensively in the manufacture of the moving parts of high-speed engines.

How things are Made—(*Continued from page 445*)

operations are carried out, the pipe branches are faced, and the necessary stud and bolt holes are drilled. When the sand and core irons have been removed the internal surfaces are chipped clean and smoothed. Between each operation the parts are subjected to the most careful inspection for errors and flaws, in order to ensure the required high standard of workmanship.

The manufacture of the wheel spindle or shaft requires the greatest accuracy. The necessary length of metal is cut from the rough bar, turned and screwed on a lathe, and then ground on a special type of grinding machine to an accuracy of .001 in.

The next operation is performed in the fitting shop, where various parts such as diffusers, sealing rings and neck bushes are fitted. The parts are then sent to the general erection shop, where the main castings are assembled, aligned and the pump made ready for testing.

The completed pump now passes to the hydraulic pressure test stand, and is subjected to twice the maximum pressure at which it will be required to work. In the case of direct coupled motor-driven pumps, each is lined up on a bedplate and tested very accurately for output and power consumption. For the purpose of the test the pump is placed on a stand, beneath which is a large tank. The suction branch of the pump is connected to this tank, and the delivery branch is led to a second tank equipped with a patent recorder. The current consumption is accurately checked by voltmeters and ammeters, and double checked by watt meters.

After testing, the pump is sent to the overhauling bay and taken to pieces. All the parts are then re-examined, cleaned and re-assembled, and finally the exterior is painted.

For the illustrations to this article we are indebted to the courtesy of the Pulsometer Engineering Co. Ltd., Nine Elms Works, Reading.

Insects as Engineers—(*Continued from page 460*)

masonry. When the young insect has developed into a moth it does not emerge from the wide entrance to the cell, but from the apex or the cone-shaped end of the cell, taking care to cover itself with threads of silk before launching out into the world in its new state. This thread it can break through easily.

The mining caterpillar, which is of similar species to those just mentioned, eats out a gallery through a leaf, strengthening and overlaying the passage as it moves forward. The many operations are extremely minute, a fact that adds greatly to the wonder of the work. The rose leaf is a particular favourite of the mining caterpillar, but these insects also work on the bramble and primrose.

Story of Sandstone Boulder—(*Con. from p. 467*)

the days of river fords, when only by their aid as submerged stepping stones were rivers crossed, or water-logged morasses and treacherous marsh-land negotiated. We also have a few examples of the stepping-block or mounting-block left to us, reminiscent of the days when there were no roads as we now understand the term. The country then had only reached the stage when drove-ways and pack-ways threaded their tortuous, difficult and dangerous courses through forests and over hill and dale.

Here and there a relic of those times may be found hidden by rough undergrowth, by the abandoned track-ways of old. Two such stones lie all but invisibly near the home of the writer. Standing near these, in the deep water-carved ravine embowered by ancient trees, one delights to conjure up a picture of the days when the pack-horse alone was the means of transport from coast to interior. These were dangerous tracks to follow, for the pack-men, little short of brigands, were a rough fearless set, holding life cheaply. No small amount of the trade by these routes was contraband, the pack-men working in conjunction with the smugglers. At that time smuggling was a staple industry, and the running of cargoes of wool to the Continent was said to be even more remunerative than the importation of French brandy or Flemish lace. In this illicit traffic even influential people in Church and State took part, and churches were sometimes actually used as store-houses for smuggled goods! At Lympne, Brookland, and other Marsh towns, beneath the huge square church pews were found large chambers doubtless used for secreting tubs of Hollands and other contraband. In the operation of this nefarious business those not actually concerned looked the other way—it was safer to do so!

Mysterious Sky City of Peru—(*Con. from p. 453*)

priests, nobles, and temple virgins who fled from the Spanish conquerors, citing as proof the fact that the masonry is not so perfect as the finest masonry in Cuzco, and consequently must have been built in later decadent days when the art of stone cutting was on the decline. They believed it was built about 1540-1550, and that through disease, famine, drought or some other cause, became depopulated in later years and gradually fell into decay. But all this is conjecture. Nothing definite can be said except that Machu Picchu is one of the wonders of the world, a miracle of stone, perched on the top of a mountain where it was built in some unknown time, by some unknown race, for some unknown reason. And that, I must confess, is not very definite.

For permission to reproduce this interesting article and the illustrations, including that on which our cover is based, we are indebted to the courtesy of the Editor of "*The Grace Log*."

Free Booklets for Cyclists

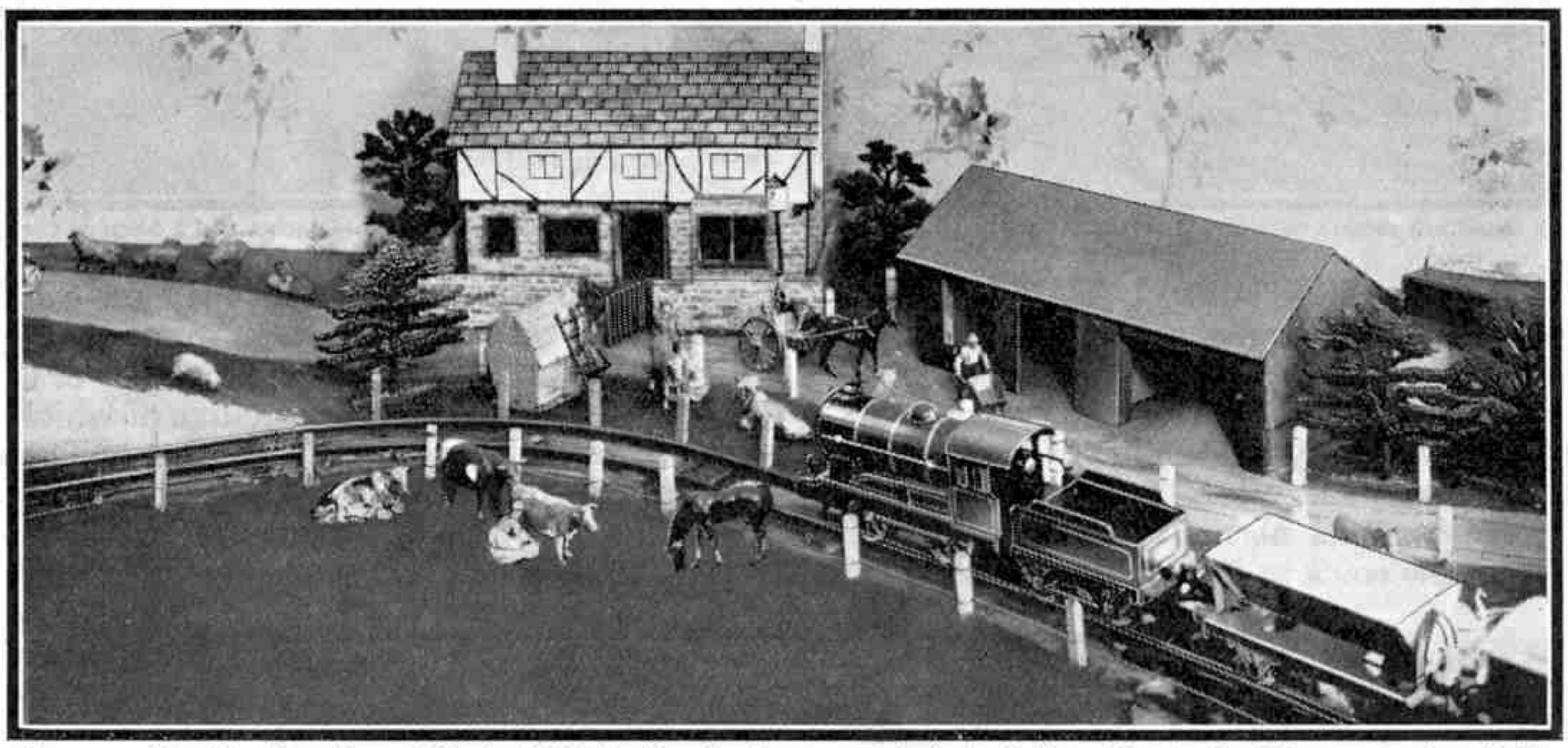
Our cyclist readers will be interested to know that the Renold and Coventry Chain Co. Ltd. are distributing free two useful little booklets for cyclists. The first is a handy pocket sectional road map of the British Isles, showing all the principal routes throughout the country. The maps are excellently printed, every detail that is really essential being clearly shown. The second booklet, which is entitled "*Easy Cycling*," is also of pocket size, and is full of helpful tips to enable the cyclist to get the utmost pleasure out of his cycling. It deals with such practical matters as position on the saddle—a matter of considerable importance on a long ride—the art of pedalling, lubrication, and the care of the chain, and includes a table of lighting-up times.

The Renold and Coventry Chain Co. Ltd., Renold Works, Didsbury, Manchester, will send copies of these booklets—while supplies last—free of charge to any reader who writes mentioning the "*M.M.*"

Give Your Bike a Chance

Lubrication plays such an important part in the care of bicycles that a word of warning on the subject will be useful at this time of the year. A leading cycle manufacturing firm state that their agents report an increasing use of unsuitable oils for lubricating the wearing parts of cycles. Instances are given of linseed oil being used; while it is no uncommon thing for owners to admit that they have been guilty of taking salad oil from the pantry to make the bike go better! Such ignorance or carelessness leads to hubs and three-speed gears becoming rusted up, clogged, or otherwise damaged, resulting in expense on repairs to the machine.

If proper cycle oil were expensive or at all difficult to obtain there might perhaps be a certain amount of excuse for neglect of lubrication, but this is not the case. Supplies are to be had from cycle dealers in every town and village throughout the country. The quantity required is small, and a sufficient amount of first-class oil to last for twelve months costs only a few pence.



A corner of the Hornby railway of Master F. H. Chaffer, showing a goods train hauled by a Hornby No. O Locomotive in a lifelike countryside scene. The model village of which a portion is shown includes a blacksmith's forge and a half-timbered farmhouse. On page 290 of the April "M.M.," Master Chaffer was shown presenting a Summit Pen to the driver of "The Royal Scot."

A Canadian Model-Building Competition

The recent Annual Model-building Competition promoted by Messrs. Barber and Holdcroft, of Victoria, B.C., aroused keen interest among local model-builders. There were many splendid entries in each of the three classes into which the contest was divided, and the judges had a difficult task in deciding the winners. Their awards were as follows: Class One (Boys over 12): 1. H. Hipkin and N. R. Stewart; 2. R. Hundleby; 3. F. Ward; Special Mention: G. P. Kidd; O. Norris-Elye (all of Victoria, B.C.). Class Two (Boys over 9): 1. W. Walker (Victoria, B.C.); 2. D. J. Rose (Saanich, B.C.); 3. E. P. Mangin (Victoria, B.C.); Special Mention: C. P. Layard (Sidney, B.C.); D. Franklin (Victoria, B.C.). Class Three (Boys under 9): 1. J. Cook; 2. E. R. McManus; 3. S. Hardinge (all of Victoria, B.C.).

For Sutton (Surrey) Readers

Many excellent models were submitted in a Meccano Model-building Competition organised recently by William Pile Ltd., 46-50, High Street, Sutton. The models were judged by a representative of Meccano Ltd., and the awards were as follows: Class A (boys from 5 to 8), 1. G. Rowley. 2. J. D. Kibble. Class B (boys from 9 to 12), 1. D. Sutton-Smith. 2. D. Clayton. Class C (boys up to 15 years), 1. E. P. Gawne. 2. L. K. Rayner.

The "Skybird League"

In view of the many applications from Skybird enthusiasts who wish to be associated with the League but who, for one reason or another, are unable to join or form a Skybird Club, it has been decided to accept associated members of the Skybird League. A distinctive badge will be issued to such members. Full particulars and application form may be obtained from the Skybird League headquarters, 3, Aldermanbury Avenue, London, E.C.2.

H.R.C. COMPETITION PAGE

Competitions appearing on this page are open only to members of the Hornby Railway Company. Envelopes containing entries should have the title of the competition clearly written in the top left-hand corner and should be addressed to the Hornby Railway Company, Meccano Ltd., Binns Road, Liverpool 13. The name, address and membership number of each competitor should appear in clear writing on the back of every sheet of paper used.

FIFTH LOCOMOTIVE NAME AND NUMBER CONTEST

This month we return once more to an old favourite among H.R.C. competitors, the well-known Name and Number Contest, which involves the deciphering of jumbled locomotive names and numbers. Our correspondence shows that H.R.C. members continue to be as keen as ever in collecting locomotive names and numbers, and the remarkable popularity of this type of competition is no doubt due to the fact that it gives such enthusiasts an opportunity of making use of their knowledge.

The accompanying panel contains the names and numbers of 48 locomotives, in which the letters and figures respectively have been jumbled up. Competitors are required to re-shuffle these into their correct positions, and to make a list of the names and numbers thus obtained.

6121	Rofhdostrrwoesee	5160	Mahhalrereocngidn
4245	Mebrelg	8405	Lecsebrekyaelt
2693	Lamgemcalmore	658	Hisiorajwksnhn
0957	Ticnepea	0691	Viernhknyg
875	Repralrdosoidetam	182	Erihsontrabumd
582	Elhrlawiaesrigtr	1995	Tikdolcenherr
9054	Holnuthliwbear	6014	Mftjmjzsaseaie
6135	Cmnslfeeiiaha	3242	Dtnhelseee
473	Selyenons	9023	Lpnratdaothin
9124	Degijnggornilei	1539	Hrasolnulth
0514	Dacrotsoglehic	8653	Jevarcheamlsersel
1256	Sclnhrwthcaaiie	279	Ververdieslirseh
2593	Truocmahnyac	4786	Wavetartdirisds
3270	Lllssyebie	0465	Bashmeevyeab
3950	Hintanlolhangn	1935	Cadseldkab
423	Sikyehrro	4055	Dajtuln
6792	Tipena	2954	Cogloutnirlhidn
773	Nugkrheti	6661	Firdondagleolnribe
1206	Cirithpnelzebsesa	7259	Tenresiralpserm
9652	Dutalgarie	3369	Olewdynhath
572	Telteni	0465	Dddralilnon
5648	Oisnovdegergad	4695	Nughatcofkodnue
4622	Lanhetsabdas	3195	Lerhyalheahlt
379	Zirelsotnak	0064	Egescineesunrip

Many of the jumbled words appear as if they would never resolve themselves into a respectable locomotive name, but in spite of appearances it will be found that after a certain amount of juggling of letters the names of the locomotives concerned will appear out of the confusion. In solving the contest readers should first decipher the name of the locomotive, and then its number can readily be found. For example, the letters of the first name on the list, if properly arranged, become "*Sherwood Forester*," and when this name has been settled it is an easy matter to find the correct number, which is 6112.

When a competitor has solved all the jumbled names and numbers, or at any rate as many of them as he is able to manage, he should make a neat list of them on a sheet of paper, together with his name, full address, and H.R.C. membership number.

The contest will be divided as usual into two Sections, Home and Overseas. Prizes of Hornby Train goods (or Meccano products if preferred) to the value of 21/–, 15/–, 10/6 and 5/– respectively will be awarded to the four best entries submitted in each section. In the event of a tie for any prize, neatness will be taken into consideration when the final decision is made.

Envelopes containing entries should be marked in the top left-hand corner "*H.R.C. June Name and Number Contest No. 5*," and posted to reach Headquarters at Meccano Ltd., Binns Road, Liverpool 13, not later than 30th June. Entries from competitors in the Overseas Section should be posted to arrive on or before 29th September.

Railway Photographic Contest

Our monthly H.R.C. Photographic Contests are being run to provide intending competitors with the widest possible scope, prizes being offered for the best photographs submitted of any subject of railway interest. The only restriction we make is that each exposure must have been made by the competitor. Developing and printing, however, may be the work of a professional.

Members may submit as many prints as they desire, but no competitor can win more than one prize in one contest. Entries will be judged more on their railway interest than on their technical excellence, but in the event of a tie between any two photographs that are in the running for an award, the photographic merits of the print will be the deciding factor.

Every print sent in should have on the back the name and address of the sender, his H.R.C. membership number, and a short description of the scene of the snapshot. Four prizes will be awarded in each Section, Home and Overseas, to the value of 21/–, 15/–, 10/6 and 5/– respectively.

Envelopes containing prints should be clearly marked "*H.R.C. June Railway Photo Contest*," and posted to reach Headquarters at Meccano Ltd., Binns Road, Liverpool 13, on or before 30th June. The closing date for the Overseas Section is 29th September.

Drawing Contest

We have pleasure in announcing this month the next Contest in our series of Drawing Contests. These Contests have proved more popular each month since their inception in January. This proves to us that among H.R.C. members there are many artists who possess a keen knowledge of railways. The subject we have chosen for our competition this month is "*A Signalman At Work*," a familiar sight to all travellers by rail. Competitors may illustrate any of the duties of a signalman, and need not restrict their attempts to the most common operation, that of "pulling the levers." Drawings may be submitted in pencil or in colour as desired, but the prizes will not necessarily be awarded to the entries submitted in colour.

To the senders of the four best drawings received in each Section, Home and Overseas, prizes will be awarded consisting of Hornby Train or Meccano goods to the value of 21/–, 15/–, 10/6 and 5/– respectively. The sender's name, full address and H.R.C. membership number must be written on the back of each entry.

Envelopes containing entries must be clearly marked "*H.R.C. June Drawing Contest*" in the top left-hand corner, and posted to reach Headquarters at Meccano Ltd., Binns Road, Liverpool 13, on or before 30th June. The closing date for the Overseas Section is 29th September.

Unsuccessful entries will be returned provided that a stamped addressed envelope of suitable size is enclosed. Entries that gain awards automatically become the property of Meccano Ltd., and will not be returned.

COMPETITION RESULTS

HOME

March "Model Railway Photo Voting Contest."—First: J. CRAWLEY (30035), Edge Hill, Liverpool 7. Second: K. COSTAIN (5108), Bolton, Lancs. Third: C. G. GIBSON (24036), Emyvale, Co. Monaghan, Ireland. Fourth: K. WAGER (27343), Halfway, Sheerness. Consolation Prizes: H. D. FULLER (38303), Hull; C. E. CHOWN (30438), Slough, Bucks.; J. URE (28119), Edinburgh; G. BARTLAM (37822), Nuneaton; P. SAWYER (36360), Rochester, Kent; J. C. BUTTON (10335), Crewe, Ches.

March "Drawing Contest."—First: C. A. BRUNT (10229), Leeds. Second: F. H. JONES (34409), New Barnet, Herts. Third: A. MARSH (20196), Kates Hill, Dudley. Fourth: J. K. MACKEN (23826), Bromley, Kent.

March "Essay Contest."—First: E. B. SIMPSON (36342), Sponden, Nr. Derby. Second: G. N. LOVERIDGE (26068), Penarth, South Wales. Third: A. P. TURNER (29305), Pinner Hill, Middx. Fourth: R. WALLIS (36722), Latchford Without, Warrington, Lancs.

OVERSEAS

December "Locomotive Errors Contest."—First: C. H. BROWN (21204), Sunshine, W.20, Victoria, Australia. Second: D. PARKER (38595), North Battleford, Saskatchewan, Canada. Third: M. DE LIMA (34925), Bombay 7, India. Fourth: W. J. T. WATSON (18065), West Leichhardt, N.S.W., Australia. Consolation Prizes: A. A. TIBBITTS (24271), N. Rhodesia, S. Africa; E. C. HEATH (29104), West Pennant Hills, N.S.W., Australia; M. L. MORGAN (22858), Cremorne, N.S.W., Australia; P. D. CHARLWOOD (30116), Sydney, Australia; L. B. DE LANCASTRE (38138), Lisbon, Portugal.

December "Drawing Contest."—First: C. H. BROWN (21204), Sunshine, W.20, Australia. Second: R. L. KAY, Gisborne, New Zealand. Third: W. FIGGINS (17726), Timaru, New Zealand. Fourth: P. GALDES (14183), Valletta, Malta.

2 MILES A MINUTE FOR TWELVE HOURS!

FIVE WORLD'S RECORDS

At Montlhéry on April 17th Mr. John Cobb, driving his Napier-Railton with Messrs. F. Dixon, C. Paul and C. Brackenbury as co-drivers, broke the following World's Speed Records previously held by America: 1,000 Kilometres, 6 Hours, 12 Hours, 3,000 Kilometres and 2,000 Miles, all at over 120 m.p.h.

(Subject to official confirmation)

WAKEFIELD Castrol XXL

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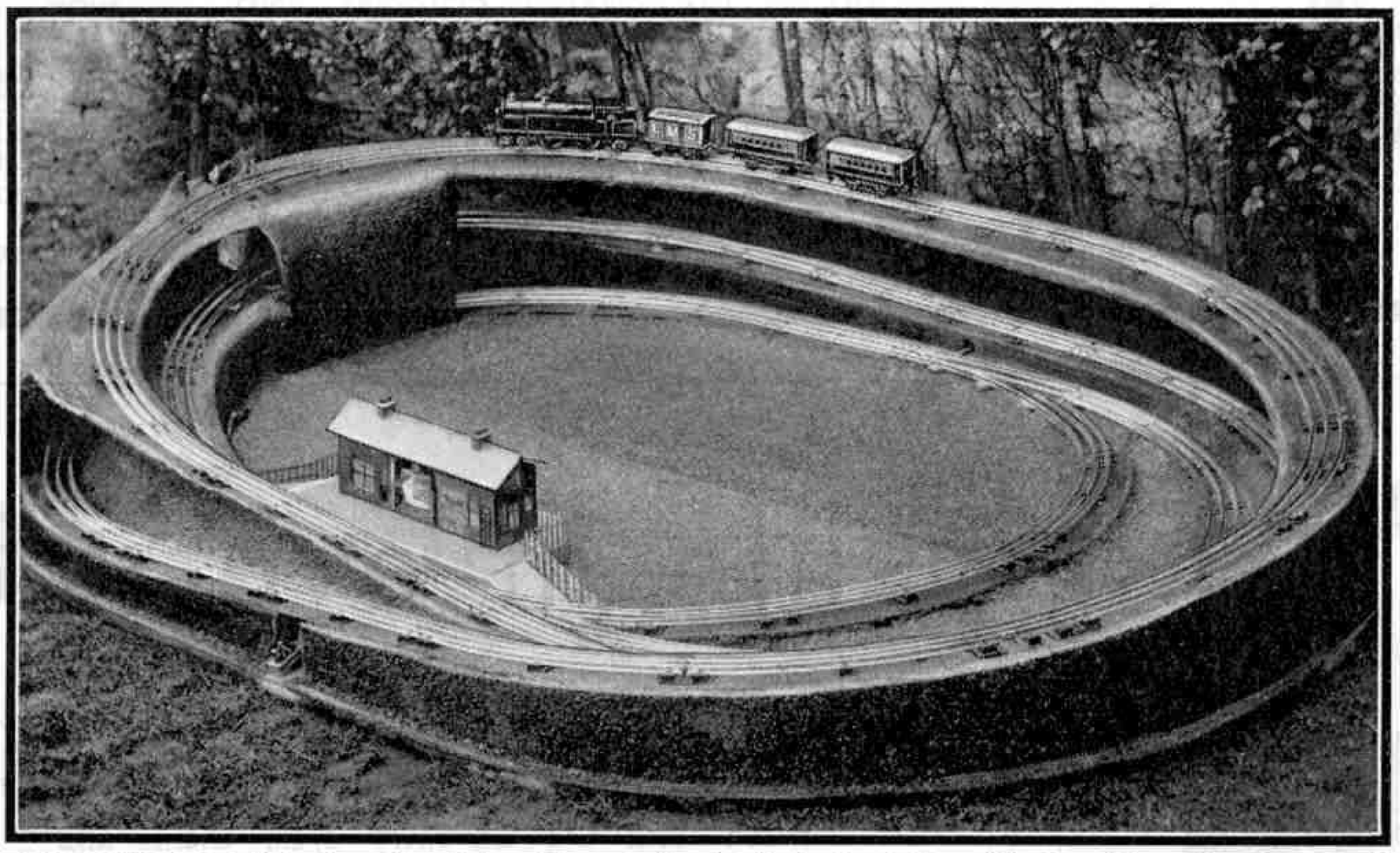
A Continuous Inclined Railway

The Layout of Mr. A. Dutton

A MINIATURE railway system, which is as unusual in character as it is interesting, is shown in the accompanying photograph. It has been constructed by Mr. A. Dutton, of Chester. The novelty of the scheme lies in the fact that whereas most miniature railways avoid gradients as much as possible, this one has been specially designed as a gradient railway, with quite spectacular results. The formation as a whole is oval in plan, but as the photograph shows there are several circuits, which are so related as to afford continuous running in an interesting manner.

To some extent the line follows the plan of a scenic railway of the kind that is so popular a feature of big exhibitions and of amusement centres, but it is arranged in a rather more railway-like style, and resembles more or less a number of flying or burrowing connections such as are found in busy railway areas. It is quite thrilling to see a train dash over the high level embankment, then descend, and suddenly plunge through a tunnel that passes under its path of a moment before.



A view of the interesting railway described on this page, showing the tracks at different levels and the various tunnels and inclines. Photograph by G. Mark Cook, Chester.

The layout is arranged on a large baseboard as the foundation, and is divided into two pieces for convenience in handling. The actual undulating "road bed" on which the track is laid consists of wood, of suitable width and specially cut to allow for the contours of the line. This is supported at intervals, and where practicable sloping embankment sides are provided, which improve the appearance of the layout considerably. These are finished off in a realistic manner. The tunnels shown in the illustration are made up and finished in a similar style and they are particularly effective in appearance.

On account of the gradients the railway is electrically operated, and this also allows long continuous runs to be made. The line is laid throughout with Hornby electric rails, firmly secured to the "road bed." Power is supplied from the mains through a Meccano 6-volt Transformer, and with a suitable load no difficulty in ascending the gradients is experienced with the No. 2 Electric Tank that is employed. This engine is provided with an electric headlight, which gives a very fine effect when the engine is traversing the low level and tunnel portions of the line.

The arrangements for securing the safe descent of the gradients are interesting. Without some reduction in the amount of current allowed to pass to the motor of the locomotive, excessive speeds and consequent disaster would result. Each descending gradient is therefore made a separate section electrically, and between the conductor rails adjoining the insulated joint at the top of the gradient a resistance element is interposed. This reduces the amperage of the current passing to the sections involved, so that the speed of the train is automatically kept in check on the descent. Constant manipulation of the control switch is thus avoided, and continuous running can be performed without fear of any mishap through bad judgment on the part of the operator.

A station is provided on the low level section, and it forms a convenient starting and stopping place for the train. Traffic working, as usually understood, cannot take such a prominent part in the operation of a line of this kind as is possible on railways of normal design. On the other hand it is most interesting to watch the train on the run, alternately climbing and descending the various slopes, and disappearing and reappearing through the different tunnel and low level sections. Such a line opens up great possibilities for those Hornby Train owners who are in search of something fresh, and we shall look forward to hearing from any enthusiasts who develop schemes of this kind.

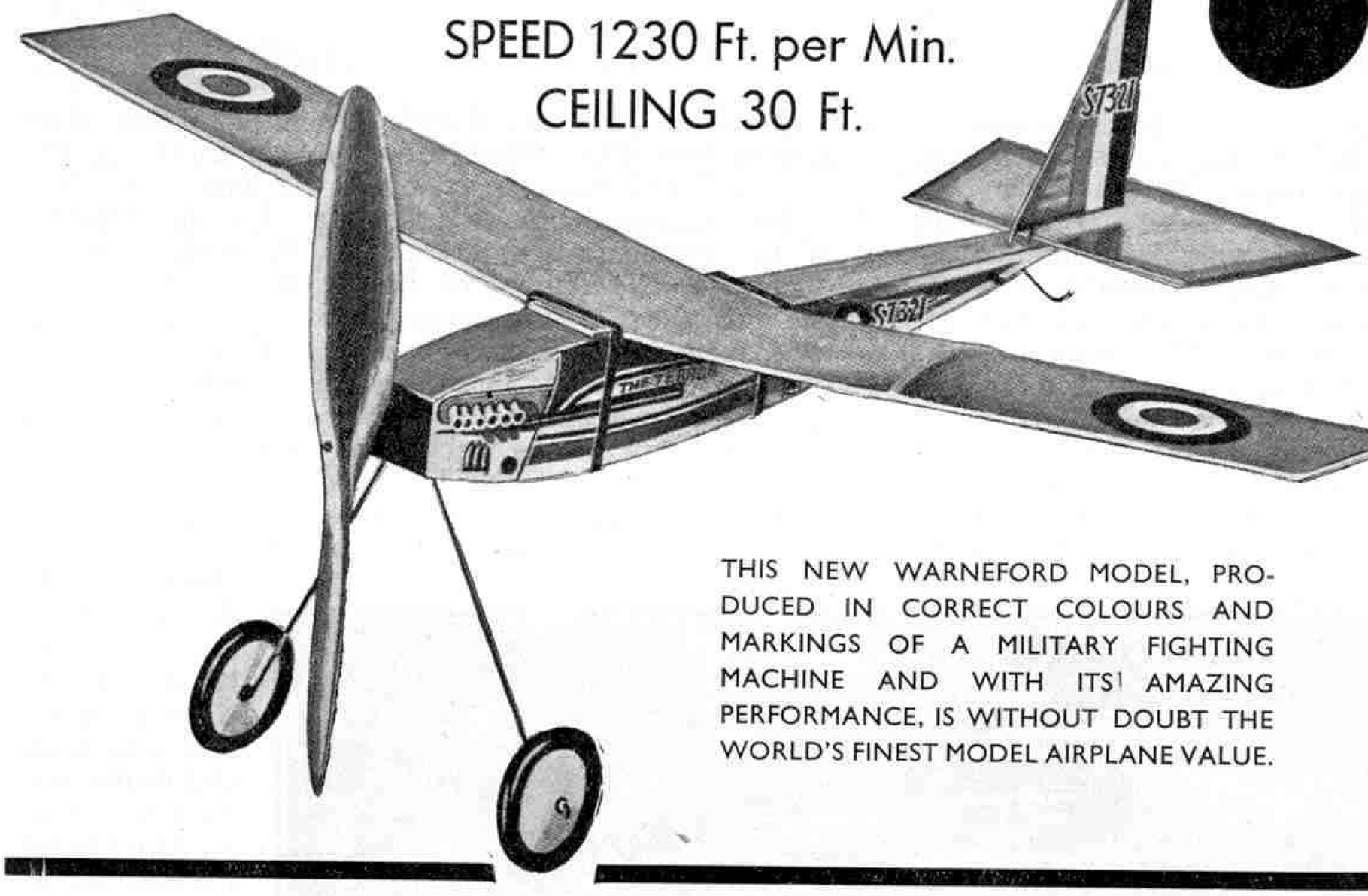
It would be interesting to base such a railway on a mountain section of some line of actual practice. The spectacular spirals on the St. Gotthard route of the Swiss Federal lines through the Alps occur to mind, and a journey over this line was described in the March 1928 *"M.M."* This line, as are the majority of Swiss railways, is electrically operated. In miniature therefore an electric system may be conveniently arranged, using the Hornby LE 1/20 Locomotive.

YOU WANT PERFORMANCE !

The "TERROR" Price 5'6

SPEED 1230 Ft. per Min.

CEILING 30 Ft.



THIS NEW WARNEFORD MODEL, PRODUCED IN CORRECT COLOURS AND MARKINGS OF A MILITARY FIGHTING MACHINE AND WITH ITS! AMAZING PERFORMANCE, IS WITHOUT DOUBT THE WORLD'S FINEST MODEL AIRPLANE VALUE.

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"ON THE 15th, AT A COMPETITION HELD BY THE "AERO-CLUB DE NORMANDIE" AT ROUEN, WARNEFORD STANDARD MACHINES CARRIED OFF THE THREE FIRST PRIZES—A SILVER CUP, BRONZE MEDAL, 250 FRANCS AND 150 FRANCS."

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FROM GOOD STORES AND TOY SHOPS THROUGHOUT THE WORLD.

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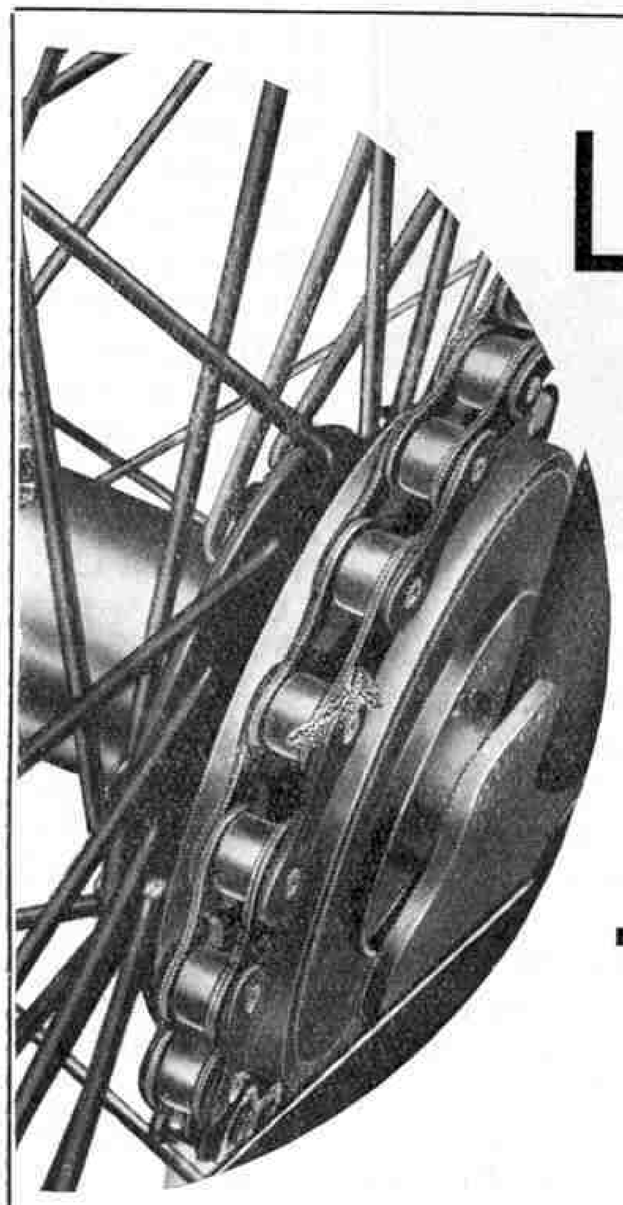
WARNEFORD FLYING AIRCRAFT (DEPT. E4), GREENWICH, LONDON, S.E.10.



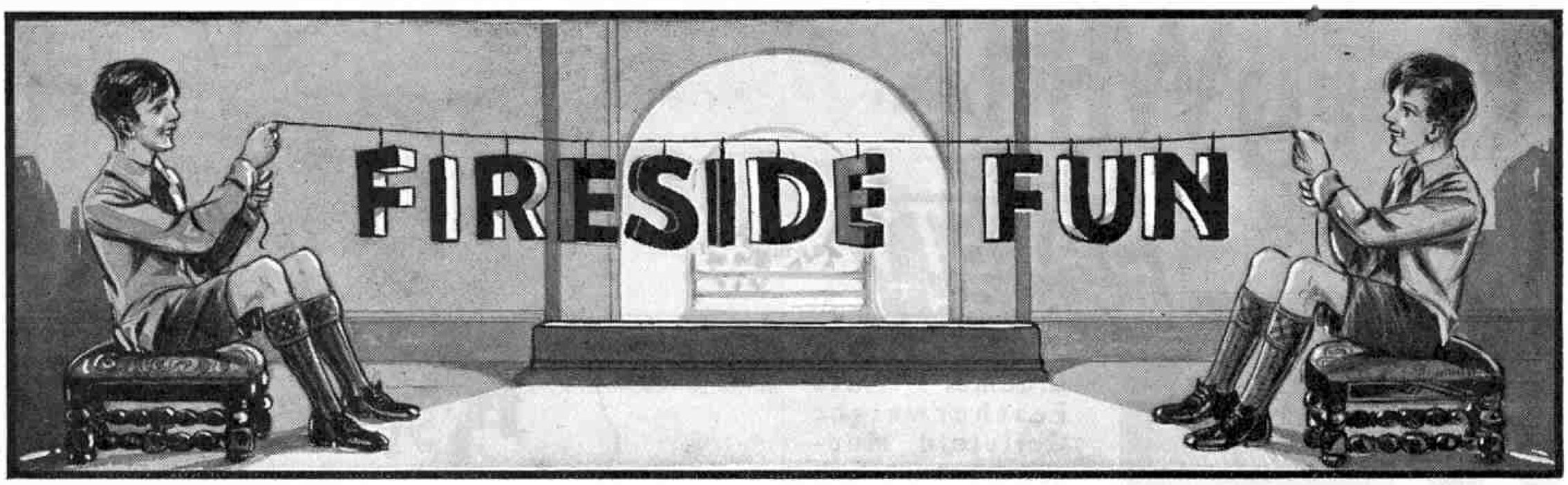
Long life in every link

Easy running is the quality that is so necessary to the full enjoyment of cycling and the easiest running machines are fitted with the Coventry cycle chains and "Elite" free wheels. When you choose your new bike look for the names stamped on the chain and free wheel first, and if you can't have your new bike this summer it will cost very little to add wings to the wheels of your old one.

THE COVENTRY CYCLE CHAINS AND *Elite* FREEWHEELS

FREE A post card will bring you a booklet on hints for easy cycling, written by F. T. Bidlake

THE RENOLD AND COVENTRY CHAIN CO. LTD., DEPT. J.1, DIDSBURY, MANCHESTER



TEA–SING CUSTOMS

"Did you know that the French drink their coffee out of glasses?"
"Yes, and the Chinese drink their tea out of doors."

* * * *

"I was tracking a bear this morning, but I lost him."
"Why didn't you keep on his tracks?"
"They got too fresh."

* * * *

First Darkie: "Ah hear you stayed in de haunted house last night. What happened?"
Second Darkie: "About twelve o'clock a ghost came through de wall just like dere was no wall."
First Darkie: "What did you do?"
Second Darkie: "Boy! Ah went through de oder wall de same way!"

* * * *

"I saw something last night I'll never get over."
"What was it?"
"The moon."

* * * *

"So you are a salesman. What do you sell?"
"I am a salt seller."
"Shake."

* * * *

Jimmy: "This here dictionary isn't any good."
Johnny: "Why?"
Jimmy: "It hasn't any index to the words."

* * * *

Mandy: "Rastus, you-all reminds me of one of dese flyin' machines."
Rastus: "'Cause I'se a high-flyer, Mandy?"
Mandy: "No, 'cause you ain't no good on earth."

* * * *

First Witness: "Tell all you know. It will not take long."
Second Witness: "I'll tell all we both know, it won't take any longer."

* * * *

Instructor: "I've told you twenty times to keep quiet. Now don't let me have to tell you a second time."

* * * *

Patient: "When should I take these pills?"
Doctor: "About an hour before you feel the pain coming on."

* * * *

Insurance Agent: "Don't you want your office furniture insured against theft?"
Editor: "Yes, all except the clock. Everybody watches that."

* * * *

ANOTHER SPOT OF BOTHER!

Vicar: "Ah, good morning, Mrs. Brown. I see you are taking a tramp into the country."
Mrs. Brown: "A tramp, indeed! I'd have you know this is my husband."

A CUTTING RETORT

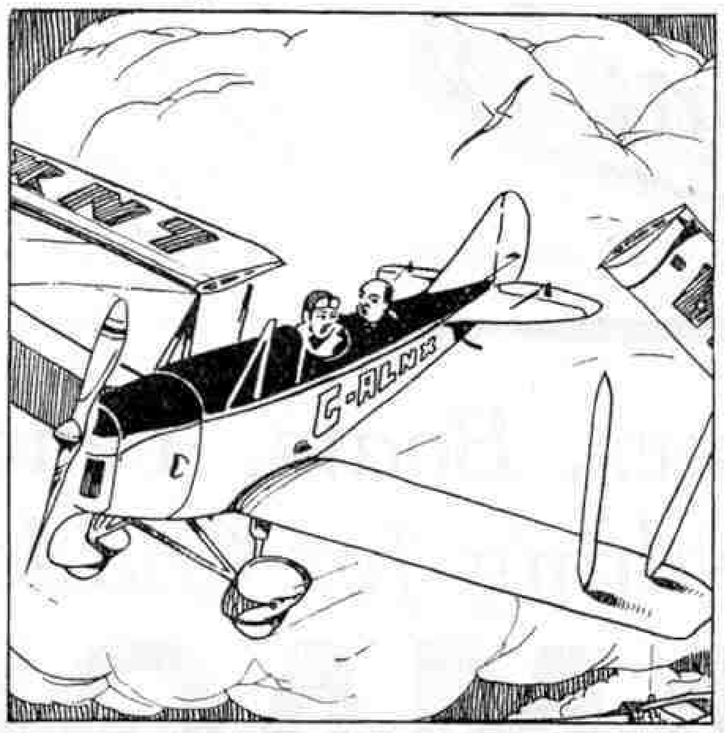
"Your hair wants cutting badly," said the barber.
"No, it doesn't," came the reply. "It wants cutting well."

* * * *

Magician (to member of audience who has continually interrupted him): "Do you want to know a trick?"
Interrupter: "Yes."
Magician: "Well, take a bath in petrol and light a match."
Interrupter: "Where's the trick?"
Magician: "The trick is to light a second match."

* * * *

THE QUICKEST WAY DOWN



Pilot: "Good heavens, the engine's stopped and the wing has come off!"
Passenger (on first flight): "Thank heaven for that. We'll be able to land right away now."

* * * *

Teacher (to new pupil): "Do you know your alphabet?"
Willie: "Yes, miss."
Teacher: "What comes after A?"
Willie: "All the rest of them teacher."

* * * *

"I'm sorry I bothered you on such a terrible night, doctor."
"That's all right, I had another patient just down the road and I might as well kill two birds with one stone."

* * * *

"Good news, old girl," he said. "I've got a job as a night watchman."
"Well!" said his wife, "if that isn't aggravating. I've only just finished making you a couple o' new nightshirts."

* * * *

John had been hard at play in the back yard. His mother, noticing his dirty face, called him into the house.
"John, I must wash your face."
"Why, muvver, who's coming?" asked the youngster.

* * * *

Teacher: "What three words are used most in the English language?"
Student (absent-mindedly): "I don't know."
Teacher: "Correct."

* * * *

Son (doing home work): "What's a square root, Grandpa?"
Grandpa (a gardener): "Er—possibly a bulb that's been knocked out of shape."

* * * *

Jones: "Why is your neighbour so unpopular?"
Smith: "He's fixed his lawn-mower so you have to put a penny in it to make it go."

A YOUNG SEA DOG

Willie's reading lesson was about ships. He came to a word he could not pronounce.
"Barque," prompted his teacher.
"Bow-wow" said Willie.

* * * *

"I'm head over heels in work."
"What's your job?"
"Acrobat in a circus."

* * * *

"What became of that hired man you got from the city?"
"He used to be a chauffeur, and one day he crawled under a mule to see why it wouldn't go."

* * * *

The instructor was explaining what to do in case of fire.
"Above all things," he said, "if your clothing catches fire, remain cool."

* * * *

Scoutmaster (arriving in camp): "Good gracious! Didn't you pack the liniment?"
Tenderfoot: "No, of course not. It was labelled 'Not to be taken.'"

* * * *

"What is salt?"
"Salt is a substance that causes potatoes to taste not so nice when there's none on them."

* * * *

Teacher: "This makes five times I have punished you this week. Now Billie, what have you to say?"
Billie: "I'm glad it's Friday."

* * * *

"That detective has sharp ears."
"Yes, I noticed the doors are all scratched around the keyholes."

* * * *

Milk Dealer: "I am in need of a boy about your age. I would pay you five shillings a week."
Boy: "Will I have a chance to rise?"
Milk Dealer: "Oh yes; I want you to be here at four every morning."

* * * *

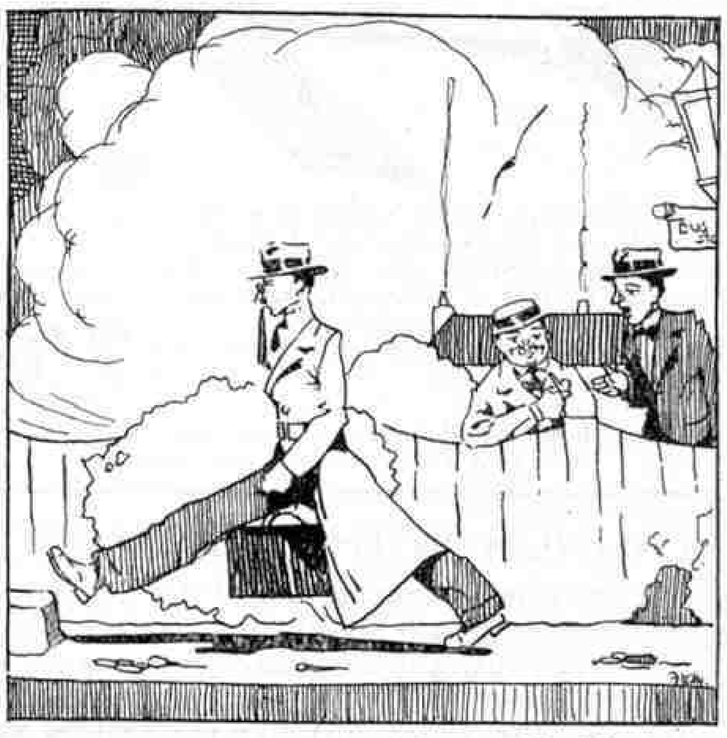
Patient: "What can I do for my weak lungs?"
Doctor: "Open the window and throw out your chest."

* * * *

"Rastus, your dog seems to be in pain."
"No, suh, he's just lazy."
"But surely he must be suffering, or he wouldn't howl like that."
"Jes' plumb laziness; he's sittin' on a thistle."

* * * *

ECONOMY STEPS



"Why is Smith taking such long strides?"
"He's got a new carpet and he's getting into the habit of walking like that so it will last longer."

Ivory White for SAFETY AT NIGHT!

Bluemel's White Featherweight Celluloid Mudguards not only look handsome but fulfil a definite safety first function.

They show up well at night and are easily seen by the overtaking traffic.

Light yet strong, they cannot chip or dent, and enhance the looks of any bicycle.

● Write for fully illustrated list, post free.

Bluemels

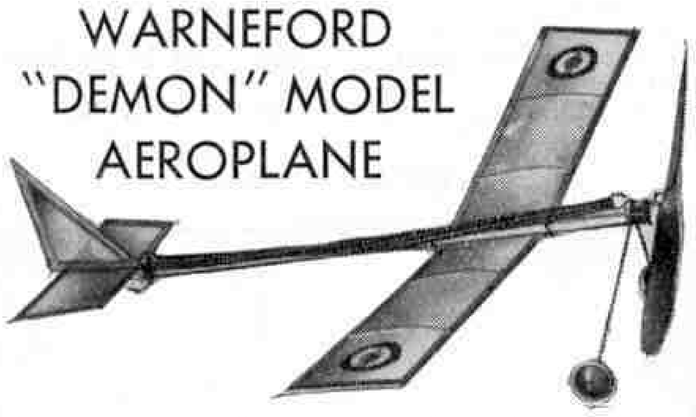
Dept. 27, WOLSTON, near COVENTRY.

"If we only had a couple of motor-bicycles we could get to the top in a jiffy if we only had some Pratts High Test."

Boys! Aeroplanes, Boats, Tents, and Everything for Outdoors Costs Less at

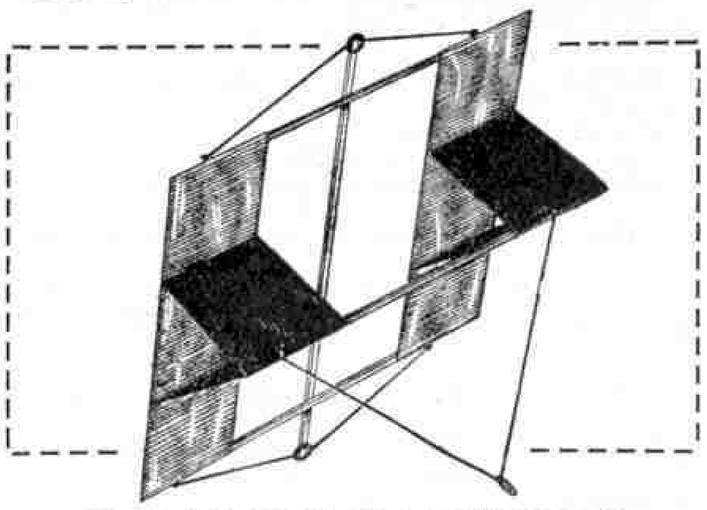
GAMAGES

WARNEFORD "DEMON" MODEL AEROPLANE



A very popular flying model of sturdy construction. Fitted with patent shockproof chassis, and covered with yellow proofed silk. Will rise from the ground and has a flight of 300 yards, undoubtedly a fine performance for a machine of this price. Wing span, 23 in. Length, 25½ in. 10 in. propeller. Price **7/6** Post 9d.

All the best model aeroplanes are demonstrated at Gamages Flying Ground—1st Floor.



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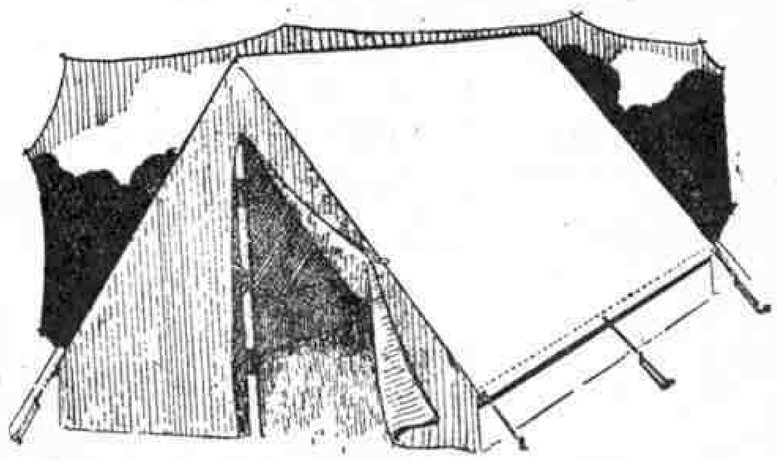
This Kite is a great flier and has been specially built for Gamages. Note the size, 25 ins. x 25 ins. It is undoubtedly the best value ever offered at the price. Price **2/-** Post 6d.



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LAUNCH WITH AUTOMATIC STEERING

The amazingly clever feature of this Clockwork-driven Boat is that it will go out in a straight line, almost 150 ft. and turn and come back towards the starting point. Speed is 100 ft. per minute, and it cuts through the water just like the real speed boats. Price (post 9d.) **17/6**

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Tel.: Holborn 8484. City Branch: 107, Cheapside, E.C.2

Competition Corner

IMPROBABILITIES

It is rather more than two years since our readers last heard of "Pawl," our office boy, but having weathered the storm created by the ghastly set of historical howlers that he perpetuated in the February, 1932, *"M.M.,"* "Pawl" has acquired wisdom. He has given up his historical studies in favour of internal combustion engines. He has hopes that one day he may emulate the feats of Sir Malcolm Campbell or Mr. Kaye Don! At least that is the explanation he offers for the amazing store of knowledge of speed records that he has dispensed about the office during the past few weeks.

Unfortunately "Pawl" has a failing. He simply cannot keep his facts sorted out, and when recently we asked him to provide a list of the outstanding feats of the internal combustion engine last year, he provided a "hotch potch" that left all his previous efforts standing!

In the centre panel on this page we reproduce five of "Pawl's" gems and we leave our readers to enumerate the errors and improbabilities with which the paragraphs are so freely sprinkled. Prizes of Meccano Products or Hornby Goods (to be selected by the winners from the current catalogues) to the value of 21/–, 15/–, 10/6 and 5/– respectively, will be awarded to the senders of the four longest lists of genuine errors discovered in the five paragraphs.

Entries must be written on one side of the paper only, and the competitor's name and address must appear at the head of each separate sheet. The total number of errors discovered should be noted at the head of the first sheet. In the event of a tie for any of the prizes, neatness or novelty of presentation of the tying entries will be taken into consideration.

Entries should be addressed "Improbabilities, Meccano Magazine, Binns Road, Liverpool 13," and must be sent to reach this office not later than 30th June.

A duplicate set of prizes will be reserved for entries from Overseas readers, those living elsewhere than in Great Britain, Ireland and the Channel Islands, the closing date for which will be 29th September.

1. The outstanding air achievement of February last was the feat of M. Maurice Rossie, of the German Air Force, who piloted a D.H. Puss-Moth fitted with two 600 h.p. Hispano-Suiza engines across the South Atlantic Ocean in record time. He started from Lympne and arrived at Georgetown, British Guiana, a distance of 4,600 miles, in 17½ hours, and was thus the first person to fly solo across the South Atlantic from East to West.

2. On 31st September of last year, the famous racing motor-boat pilot, Earl Howe, set up new records for baby cars, by driving his special super-streamlined M.G. Midget at a speed of 272 m.p.h. over distances of 50 kilometres, 50 miles and 100 miles. For this wonderful feat, accomplished on the "T.T." circuit in the Isle of Man, he was awarded the Schneider Trophy.

3. In April, Mr. and Mrs. Mollison added new laurels to their fame when they made an aerial conquest of Mount Everest. For this remarkable flight they chose a Comper "Swift" seaplane fitted with skis to facilitate their landing on the peak. The greatest height reached was 30,000 ft., from which altitude the occupants of the 'plane enjoyed a magnificent bird's eye view of the tree-covered summit of the mountain.

4. Early spring visitors to Belfast had the good fortune to witness both the Senior and Junior Tourist Trophy Motor Cycle Races. These events were particularly interesting, for the open roads, instead of the enclosed track, were used for the first time. The Senior Race was won by Mr. Sidney Woods riding a New Imperial, covering the track at an average speed of 81.04 m.p.h. The Junior event was won by Count Czaykowski, riding a Hercules, who achieved an average speed of 123.58 m.p.h.

5. On the morning of 10th April, Warrant Officer Agello, of the U.S.A. Army Air Corps, flew non-stop from Pendine Sands to New York at a speed of 423.76 m.p.h. In accomplishing this figure Warrant Officer Agello set up a new World's Duration Record.

June Photo Contest

As we announced in our April issue, the conditions of our 1934 series of photo contests permit competitors to select their own subjects. The prizes are awarded to the best photographs submitted each month, irrespective of subject, size, make of camera, plate, film or paper. The only restrictions are that each print must bear a title and that the exposure must have been made by the competitor. The developing and printing may be professionally done, but, all other things being equal, preference is given to entries that are solely the work of the competitors. Such entries should be marked "Own Work Throughout."

The competitions are divided into two groups, Home, for those living in Great Britain, Ireland and the Channel Islands; and Overseas, for those living outside those areas. Each group is divided into two sections, A for those aged 16 and over, B for those under 16; and prizes of Meccano products or Photographic Materials (to be chosen by the winners) to the value of 21/– and 10/6 will be awarded in each.

In addition to its title, each print must bear on its back the competitor's name, age and address. Unsuccessful entries are returned if a stamped addressed cover is sent for the purpose. In the ordinary course prize-winning entries are retained, and it is a condition of entry that the Editor shall have the right to reproduce any entry without fee.

Entries sent this month must be addressed "June Photo Contest, Meccano Magazine, Binns Road, Liverpool 13," and must arrive not later than 30th June. Overseas closing date, 29th September.

Competition Closing Dates

HOME		
Improbabilities	... ...	30th June
June Photo Contest	... ...	30th June
OVERSEAS		
Advertising Slogan Contest	...	30th June
March Drawing Contest	...	30th June
April Crossword Puzzle	...	31st July
April Photo Contest	... ...	31st July
May Jig-Saw Contest	... ...	31st August
May Photo Contest	... ...	31st August
Improbabilities	... ...	29th September
June Photo Contest	... ...	29th September

Watch the Closing Dates:

Competitors, both Home and Overseas, are particularly requested to make a careful note of the closing dates of the competitions.

COMPETITION RESULTS

HOME

April Crossword Puzzle.—As there is still a month to run before the Overseas Section of this competition closes, it is not possible to give the solution. For the moment it is sufficient to say that the majority of competitors encountered the only difficulty that the puzzle presented and were guilty of one mistake. Nevertheless quite a big number of readers succeeded in submitting an all correct solution, and the judges were faced with no little difficulty in deciding which were the neatest entries for the purpose of awarding the prizes. The awards were as follows: 1. C. Evans (Hale); 2. K. C. Piper (Burgess Hill); 3. T. G. Stevenson (Nottingham); 4. S. E. Smith (Enfield).

April Photo Contest.—The splendid entry to this competition augurs well for the success of the 1934 series of competitions. Many excellent photographs were submitted, and finally it was decided to augment the prizes by the grant of special awards in both the A and B Sections. The prizewinners' names are as follows: First Prizes: Section A, A. B. Bishop (Bristol); Section B, T. Warner (Tunbridge Wells). Second Prizes: Section A, A. P. Gardner (Kettering); Section B, P. J. Clems (Kew). Special Prizes: Section A, F. H. Culverhouse (Sheffield); R. A. Shone (Ashton-in-Makerfield); Section B, E. D. Loshak (London, N.W.2).

OVERSEAS

Motor Contest.—This competition, which required competitors to identify the silhouettes of well-known motor cars, provided our readers with quite a lot of fun.

Now that the Overseas Section has closed, the solution can be given. It was as follows: *1st Row.* Standard Ten; Frazer-Nash; Hillman Minx; Amilcar. *2nd Row.* M.G. Midget; Aston-Martin; Alvis; Crossley 10. *3rd Row.* Rover 10; Lea-Francis; Morgan; B.S.A. The awards were as follows: 1. E. Kilpert (Capetown); 2. A. Kannemeyer (Bloemfontein); 3. W. Kelly (Toronto); 4. A. N. Starling (Durban).

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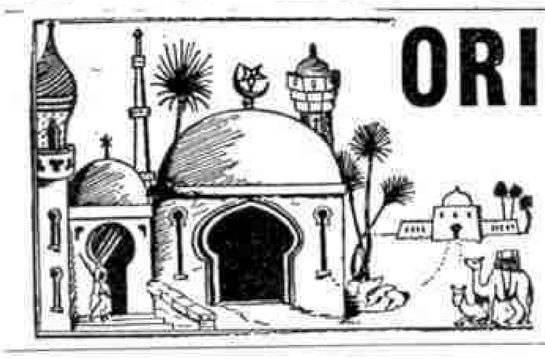

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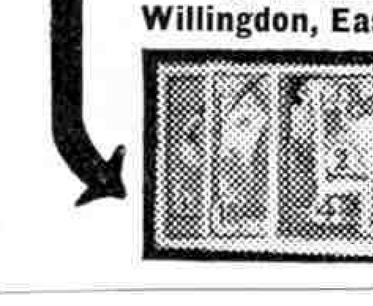

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For further Stamp Advertisements see the lower half of page 518.

Stamp Gossip

and Notes on New Issues

Summertime Collecting

Now that summer days are with us, many stamp collectors are tempted to put their hobby in the background in favour of outdoor pastimes. Although we should be the last to recommend anyone to spend indoors hours that might be spent in the fresh air, we urge our readers not to stop collecting during the summer. New issues appear in the summer in no less quantity than in the winter, and it is not easy to catch up the arrears once a series of issues has gone past. The collector who keeps quietly in touch with stamps during the summer will find his album and envelope of new issues splendid companions when it comes to filling in a rainy evening.

Quite apart from new issues, however, the "winter-only" collector misses a lot of good things. With so many of their customers losing interest in the summer, many stamp dealers make special efforts to promote additional business, and some very attractive "summer time" bargains are forthcoming.

To illustrate this point we have taken at random offers that are being made by "*M.M.*" advertisers. Mr. Victor Bancroft, of Matlock, for example, has published a special novelty booklet, "*The Stamp Finder*," that he is selling to summer collectors at 4d. post free. The purchase price will be refunded to purchasers of stamps value 1/6. "*The Stamp Finder*" is a veritable mine of information concerning stamp collecting. Mr. Bancroft is carrying his "summer" effort even further. He is offering two new issues free to every collector who undertakes to collect stamps during the summer and, as evidence of the intention, asks for new issue approval sheets to be sent each month.

Mr. H. C. Watkins, of Barnet, also has a novel plan that he describes as "permitting the collector to have his cake and eat it too." Throughout the summer all purchasers of stamps from his approval sheets will receive a gift of stamps equal in catalogue value to the amount purchased from the sheets. The offer is additional to the bonus gift usually given by this advertiser.

Messrs. Bancroft and Watkins are not alone in their summer efforts. Other of our advertisers are putting out special offers and the stamp advertisement pages will repay watching even more carefully than usual during the next few months.

A Dutch Tercentenary

The 30th anniversary of the Dutch acquisition of the West Indian island of Curacao has been celebrated by the issue of a complete series of 17 commemorative stamps, ranging in value from 1c. to 2g.50.

There are six designs in the series, all but one of which bear portraits of leading personalities in the Dutch colonial expansion. The exception is the design shown here, which is used for the 20c., 21c. and 25c. values. It shows the flagship sailed by Johannes van Walbeeck, the central figure in the early history of Dutch settlement in Curacao. No portrait of Walbeeck is available, but that he was a man of unusual talents is shown by his remarkable career in the Dutch Navy. He joined the service in 1623 as a mathematician, but in 1629 he was vice-commander of a squadron and in 1633 he led the expedition to Curacao. In July 1634, when the island was taken, he was appointed Governor of the new colony, and was solely responsible for the establishment of the complete system of administration. He returned to Holland in 1649, and died shortly afterwards.

The remaining designs show portraits as follows: 1c., 1½c. and 2c., Willem Usselinx; 2½c., 5c. and 6c., Frederik Hendrik; 10c., 12½c. and 15c., Jacob Buickes; 27½c., 30c. and 50c., Cornelius Evertsen de Jongste; 1g.50 and 2g.50., Louis Brion.

Forthcoming Issues

Hungary is to issue next year a series of stamps to celebrate the 300th anniversary of the foundation of the Budapest University. The range of values and details of the designs have yet to be fixed.

Germany is to issue a special series to celebrate the Olympic Games to be held in Berlin in 1936. Although the designs have still to be chosen, it has been decided to issue a specially fine printing of the series on art paper, for sale only in the Stadium itself!

We illustrate this month the design used on the low values of the new German air issue mentioned in the May "*M.M.*"

An Inventor Commemorated

The centenary of the death of Joseph Marie Jacquard, inventor of the Jacquard loom, has been marked in France by the issue of a special 40c. stamp bearing the inventor's portrait. Jacquard was born at Lyons in 1752 and is famous not only for his loom, but also for his many efforts to improve the lot of the French artisan.

A Turkish Commemorative

Among the most striking commemoratives of recent months, a place of honour must be given to the Turkish series celebrating the 10th anniversary of the foundation of the Turkish Republic.

There are two designs in the series of seven stamps, and we illustrate the more interesting, that used on the 3k., 6k. and

50k. values. It is worth a passing study, for it is Turkey's first venture into modern symbolism. Its complete break with tradition is a token of the new spirit dominating Turkey. Gone are the Star and Crescent and the Tougra, and in their places are the ratchets and gear wheels of modern commerce; the minarets of old-world mosques give place to the chimneys and towers of up-to-date factories, and smiling benignly over all is the laureated head of Mustapha Kemal, Dictator, creator of the New Turkey.

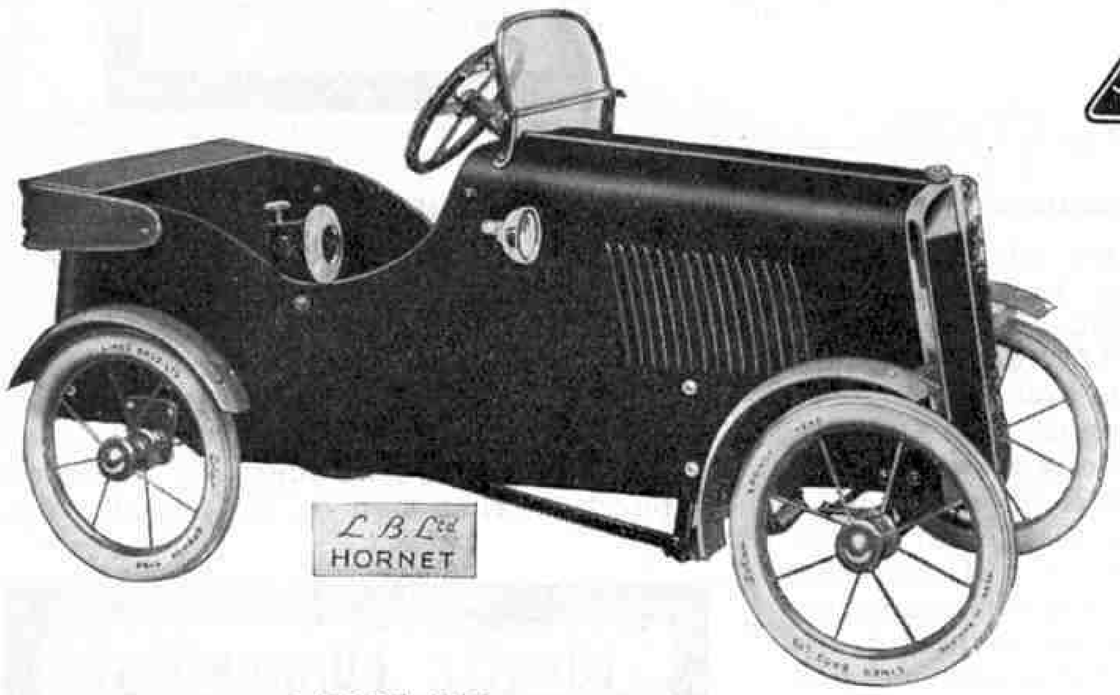
The design used for the 1½k., 2k., 12½k. and 15k., the remaining four values, is also in the modern style, but the design is entirely symbolic.

Mother's Day Stamp

One of the happiest of America's national customs is the widespread observance of Mother's Day. The movement, which was started by a simple sermon in a Philadelphia church on the second Sunday in May, 1908, now enjoys official status to the extent that the day is a National Holiday, and "Old Glory" flies over all public buildings. This year the celebration was marked by the issue of a special 3c. postage stamp, bearing as its design a reproduction of Whistlers' famous picture, "Portrait of the Artist's Mother." The stamp bears also the inscription "In Honor of all Mothers of America." It was first placed on sale on 13th May at Washington, and was subsequently available at all post offices throughout the U.S.A.

We thank Stanley Gibbons Ltd. for their courtesy in loaning the stamps from which the illustrations on this page have been made.

Cars, Tricycles, TRI-ANG Fairycycles, etc.

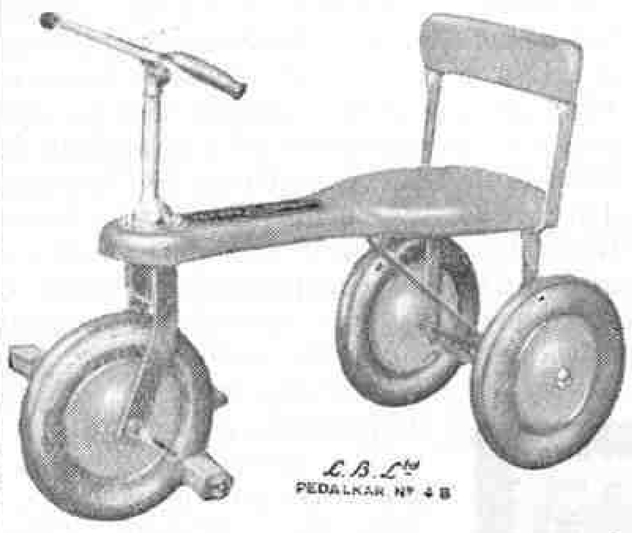


HORNET

A fine sports model with realistic radiator and coach-built body. Full equipment includes mechanical horn, wind screen with direction indicator, petrol and oil tins, etc. Easy action double crank drive. Shock-absorbing thick white sponge rubber tyres. Sports mudguards. Two lamps. Finished coloured cellulose enamel. Length 43 ins.

39/6

SEE THE FINE RANGE OF NEW TRI-ANG CARS AT YOUR NEAREST DEALERS.



PEDALKAR No. 4B

A strong toy made of pressed steel with folding backrest. Steel disc wheels and ⅝" rubber tyres. Nickel-plated handlebars, with rubber grips and pedals.

10/6

FAIRYCYCLE No. 2

Best British tubular frame. Comfortable leather coil saddle and ball-bearing pedals. Fitted with rim brake, thick white auto-tread tyres. Chromium-plated fittings.

39/6

BE SURE AND ASK FOR A GENUINE FAIRYCYCLE.

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TRI-ANG TRICYCLE No. 5. Cycle-chain drive with free wheel. Frame of best quality weldless cycle tubing. 14" wheels with 1⅛" sponge tyres. Ball-bearing pedals. Coil-spring saddle. Finished black or blue cycle enamel, gold lines. Chromium fittings.

59/6

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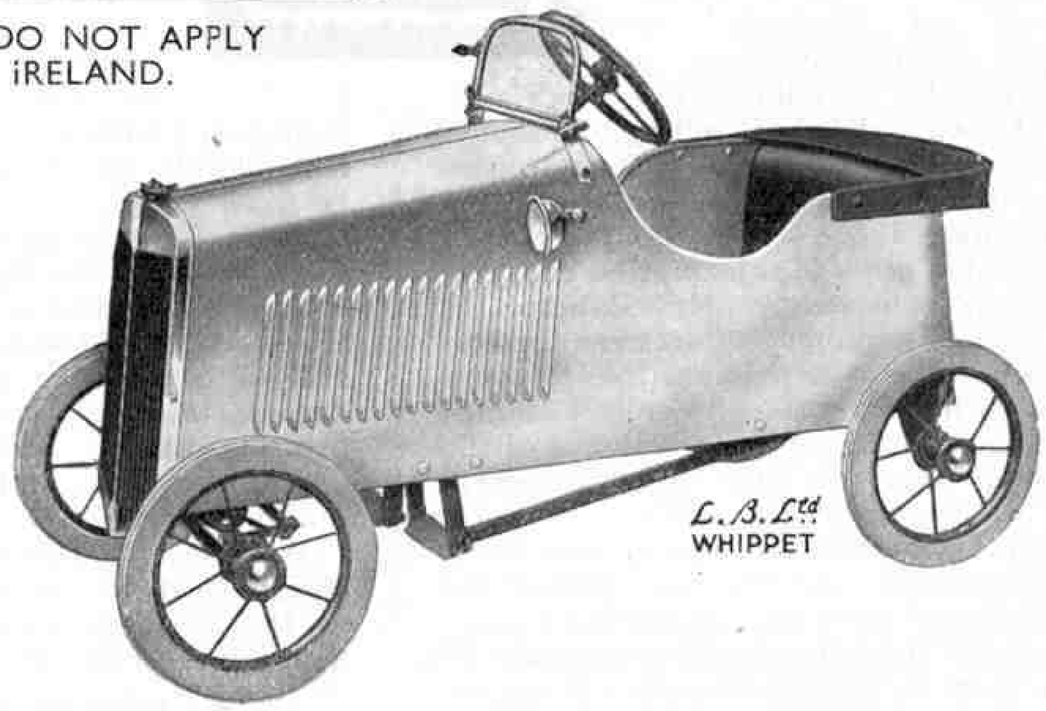

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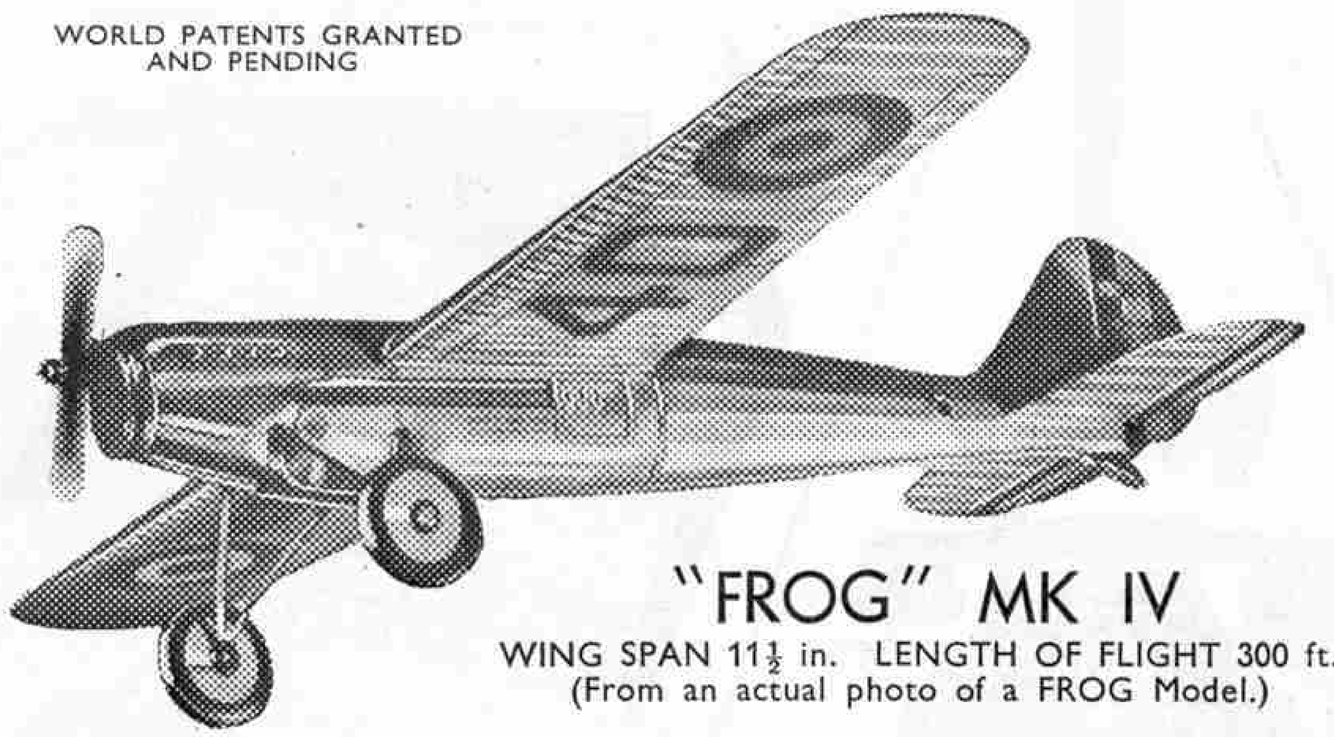
FROG *FLYING SCALE MODEL* AIRCRAFT

WORLD PATENTS GRANTED AND PENDING



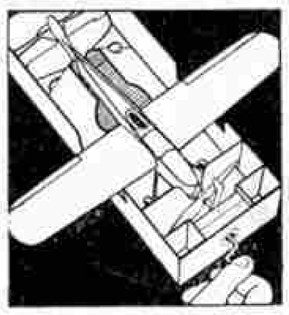
The original and now famous model. A scale model of a high-speed Monoplane. Tubular construction, patented quick detachable fittings. High efficiency air-screw. A splendid machine for realistic stunting. Watch it zoom, loop and "barrel roll." Made with the correct markings and in the full colours of seven nationalities. British R.A.F., Italy, France, Holland, U.S.A., Belgium and Argentine.

"FROG" MK IV

WING SPAN 11½ in. LENGTH OF FLIGHT 300 ft.
(From an actual photo of a FROG Model.)

PRICE
7/6
Complete with spare motors, lubricant and gear box oil, patent high-speed winder box and illustrated flying manual.

Attractive coloured transfers of famous R.A.F. squadron markings for wings and fuselage. Easily applied.
1/6 per set



The FROG AND PUSS MOTH can be quickly wound for flight with the patent high-speed winder box in which each model is packed.

From an actual photo of a FROG PUSS MOTH Model.

PUSS MOTH

WING SPAN 18 ins. LENGTH OF FLIGHT 600 ft.

A magnificent scale model of the famous record-breaking light aeroplane. All metal fuselage with bulkhead reinforcement, hollow wings of special design and construction. Dual motor coupled to gear box, glazed cabin and roof lights. "FROG" patent quick detachable fittings and high-speed mechanical winder. The model aeroplane "par excellence."

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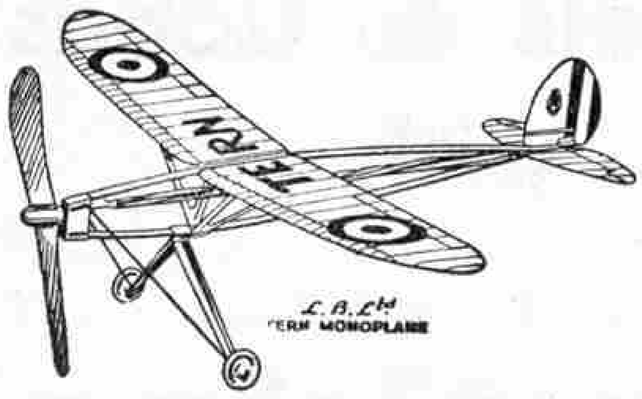
Complete with high-speed winder box, spare motor, inserter rod, gear box oil, elastic lubricant and illustrated flying manual.

Designed and manufactured by International Model Aircraft Ltd.

Own a 'FROG' or a 'PUSS MOTH' and join the FROG FLYING CLUB. Membership free, write for particulars.

"TERN" MONOPLANE



A splendid model for outdoor flying. Very durable construction. Wing Span 15 ins. Flies 200 ft. **1/6**

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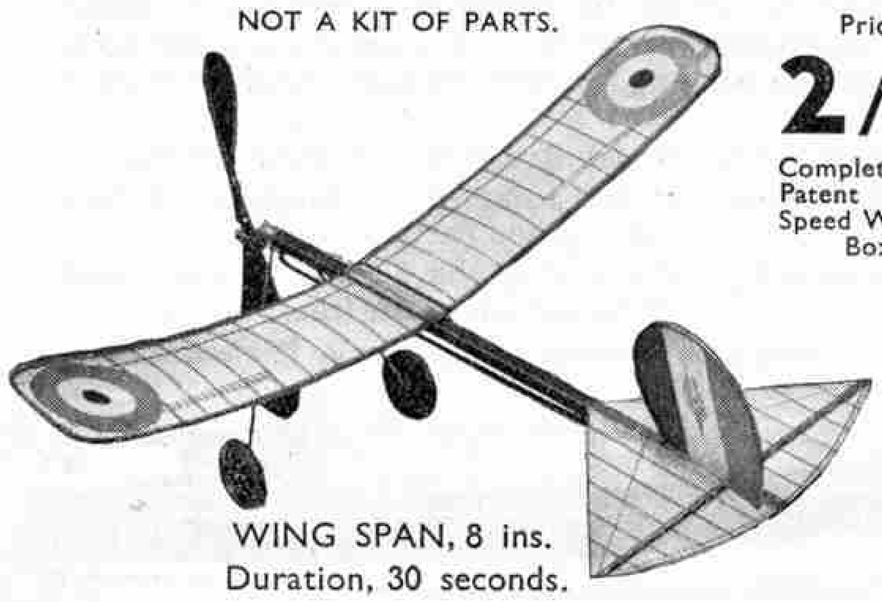

Price
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Complete with Patent High-Speed Winder Box.

WING SPAN, 8 ins.
Duration, 30 seconds.

"FROG" MODEL AIRCRAFT ARE SOLD AT ALL GOOD STORES AND TOYSHOPS

Sole Concessionaires :
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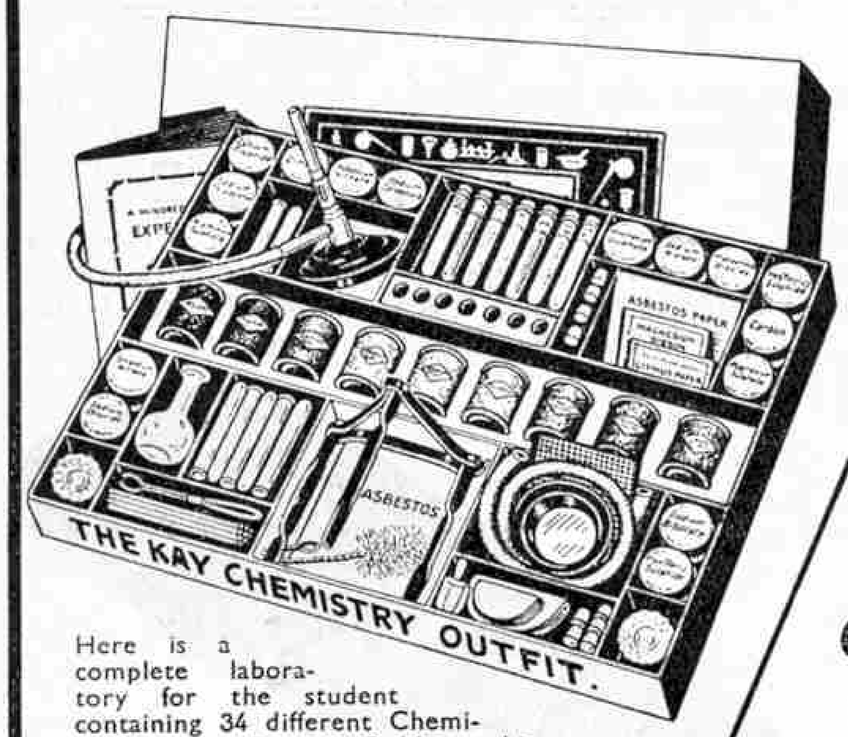

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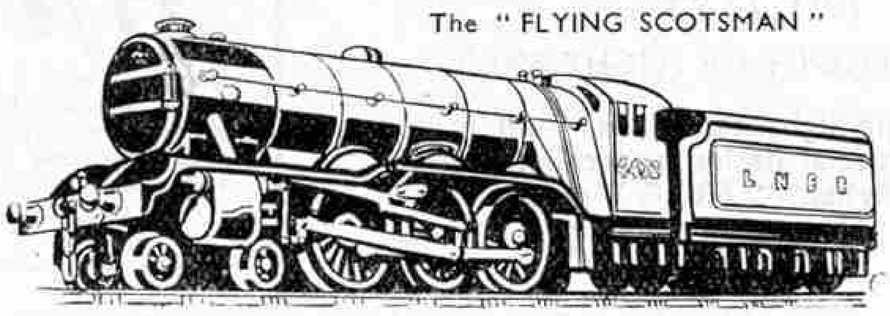

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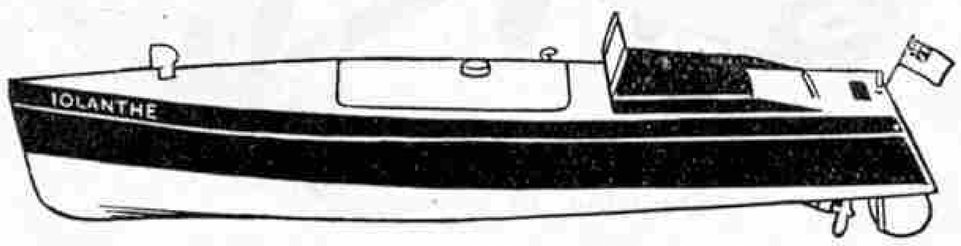

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Number Fourteen *June, 1934*

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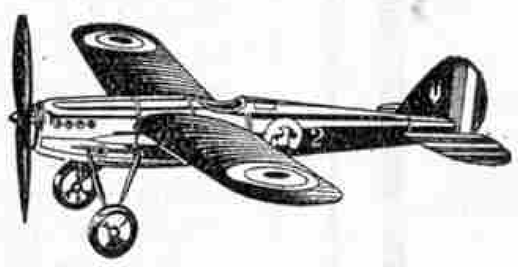

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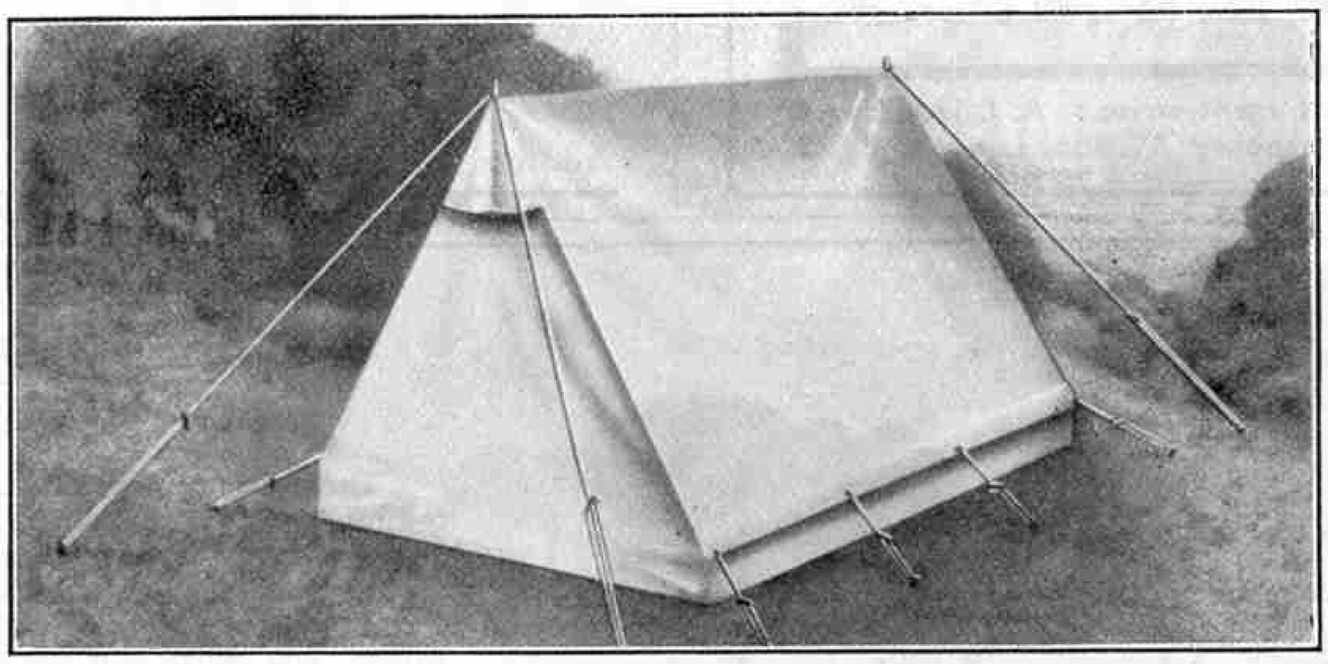
Obtainable in seven different National Colours : R.A.F., ITALIAN, FRENCH, BELGIAN, DUTCH, ARGENTINA and U.S.A.



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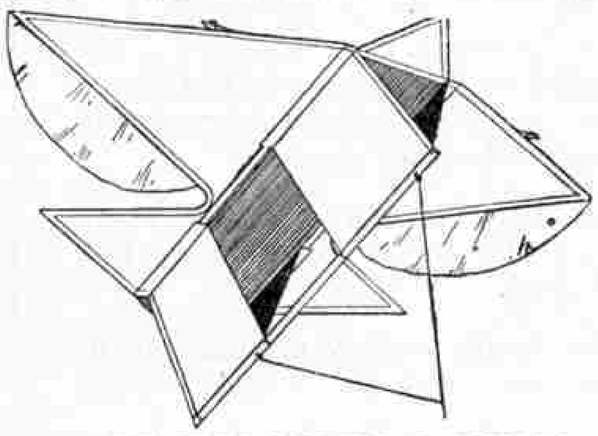

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With realistic flapping Tadpoles.
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Also a special Kite for sporting purposes.
Price 15/-. Postage extra.

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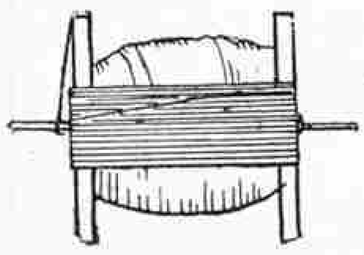

For 3/6 Kites ... 1/9
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Heavy quality rubber proofed ground sheet for either of these tents. Size : 6 ft. x 4 ft. Price 3/6

Carriage extra.

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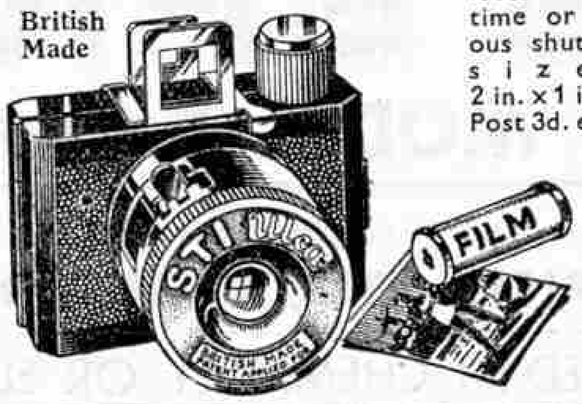

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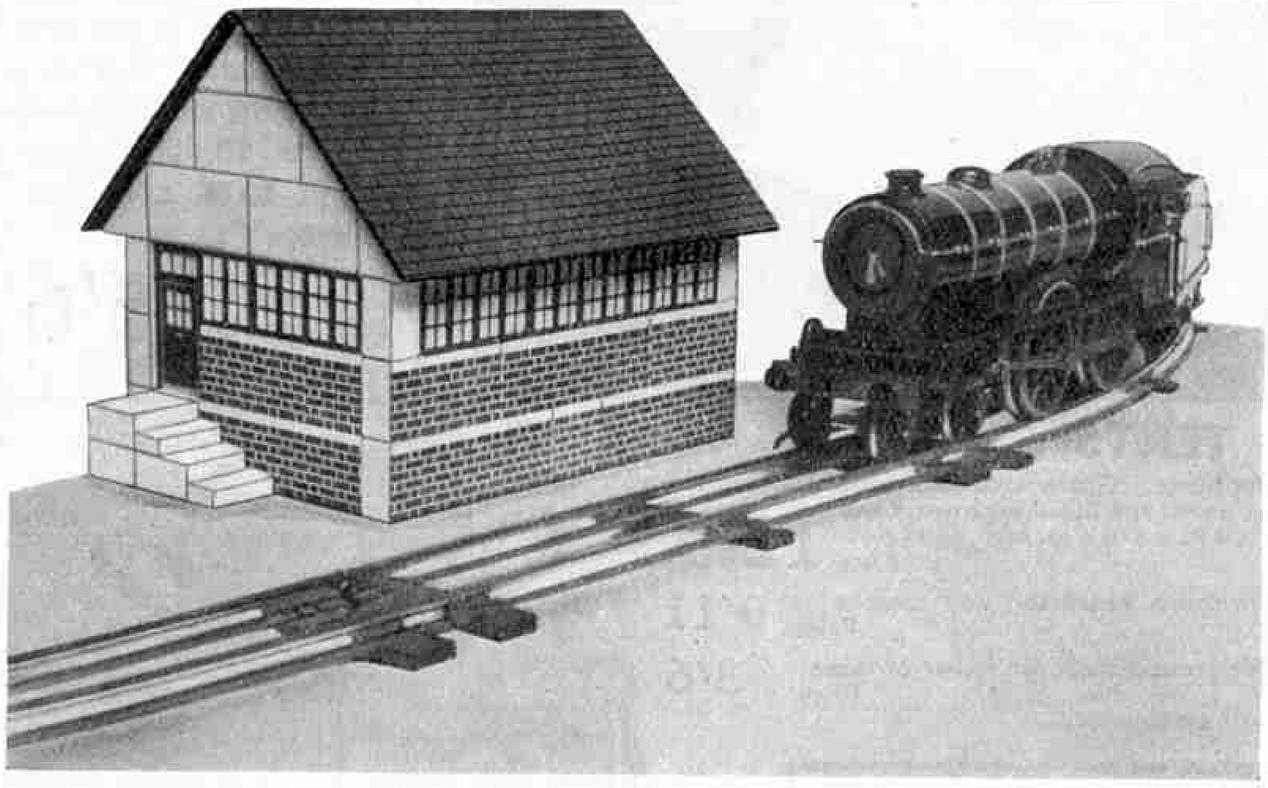

Signal Box, built with Lott's Lodomo.

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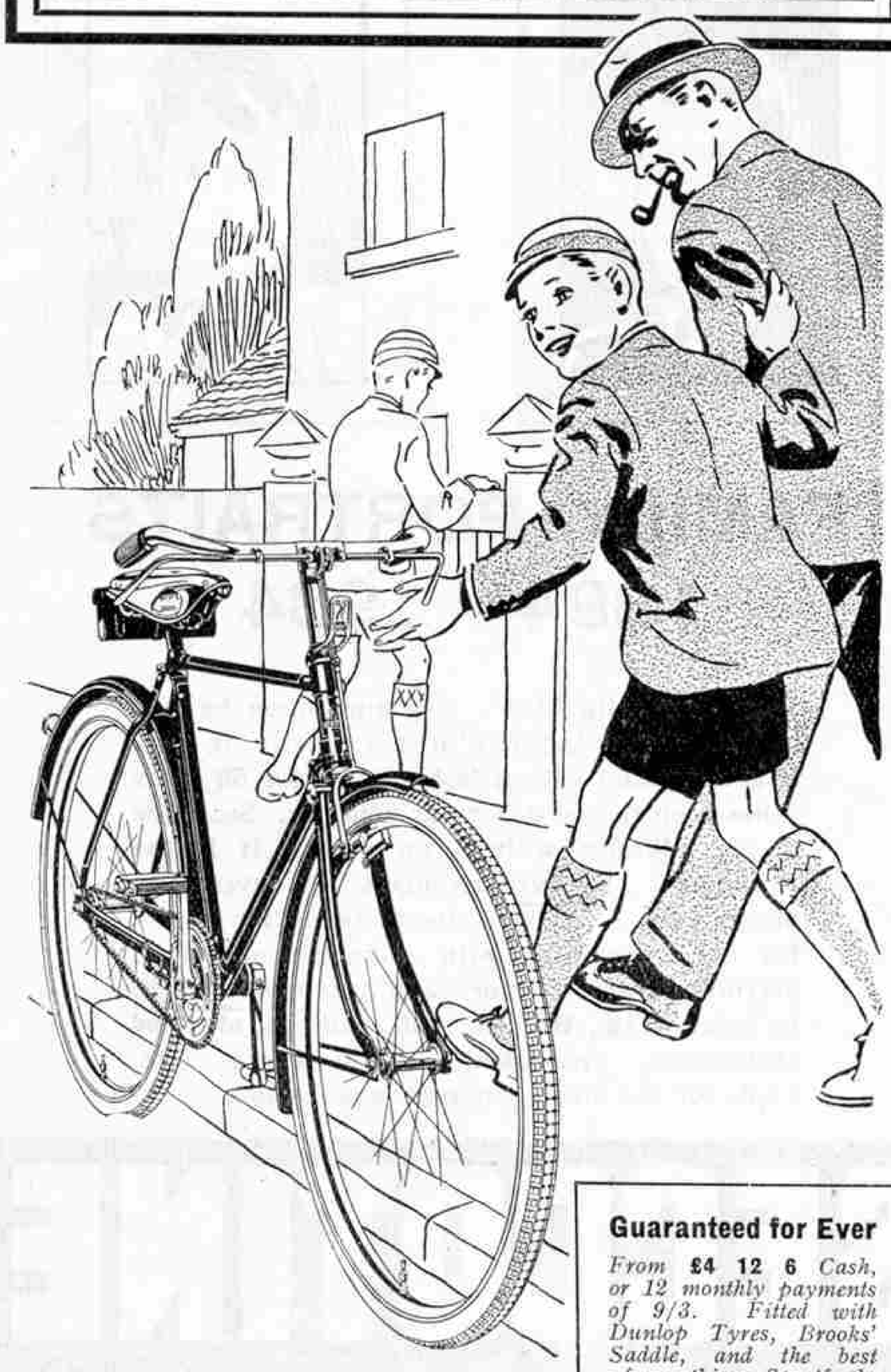
The other boys say

There's nothing to equal a

RALEIGH

THE ALL-STEEL BICYCLE



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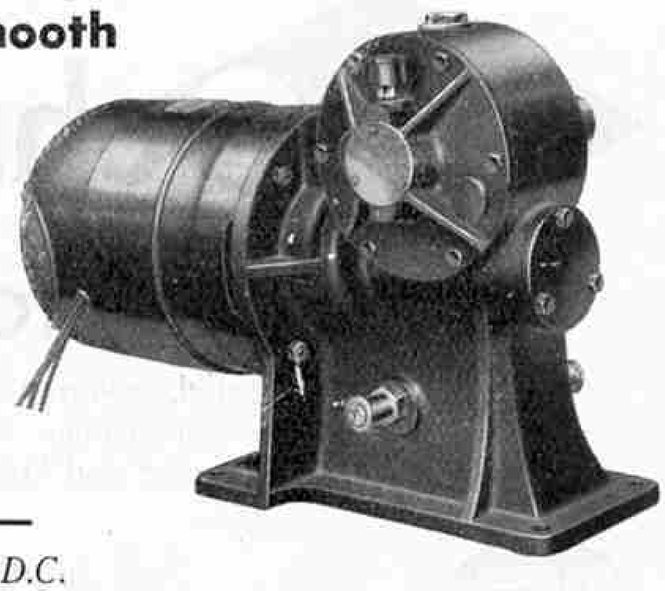

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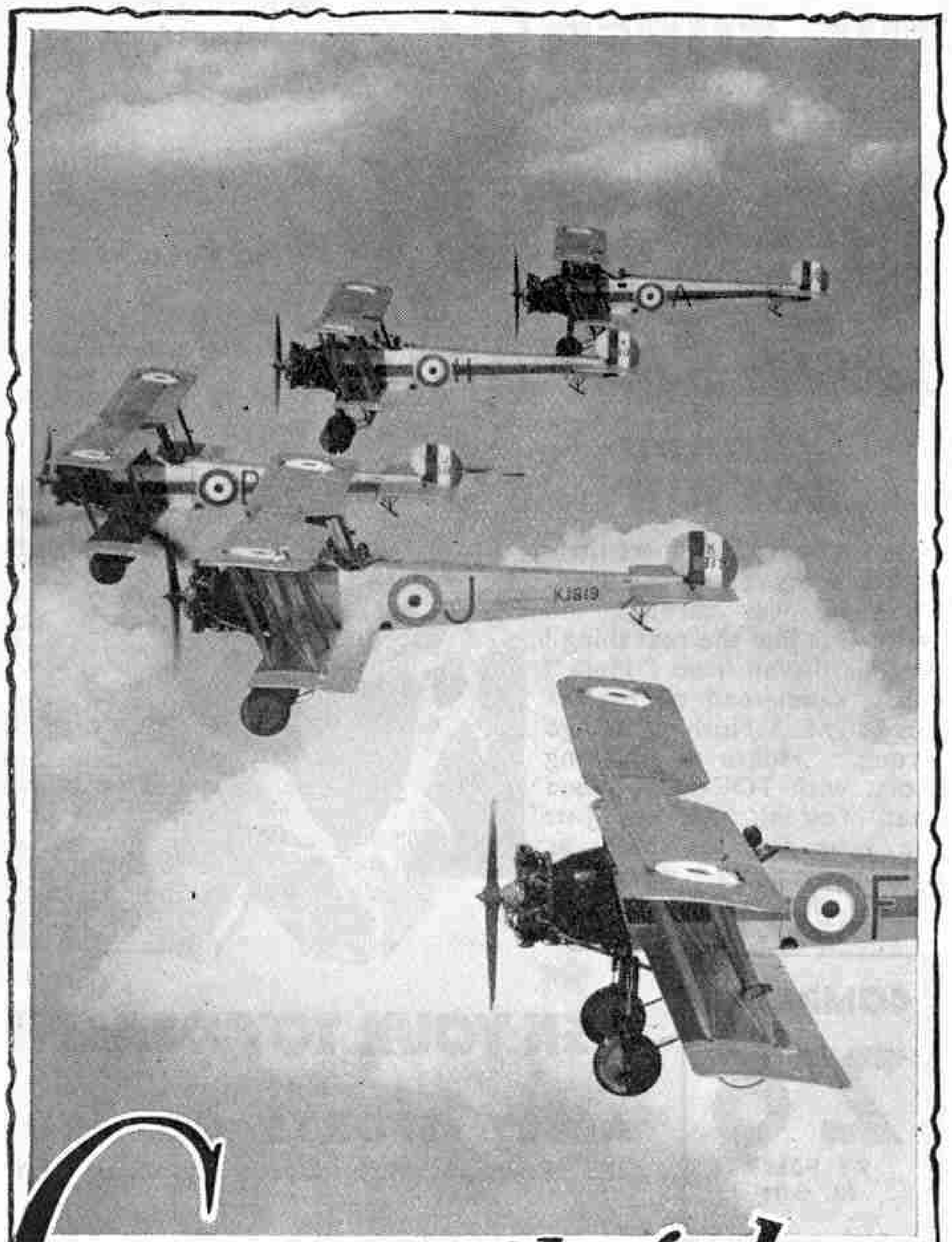

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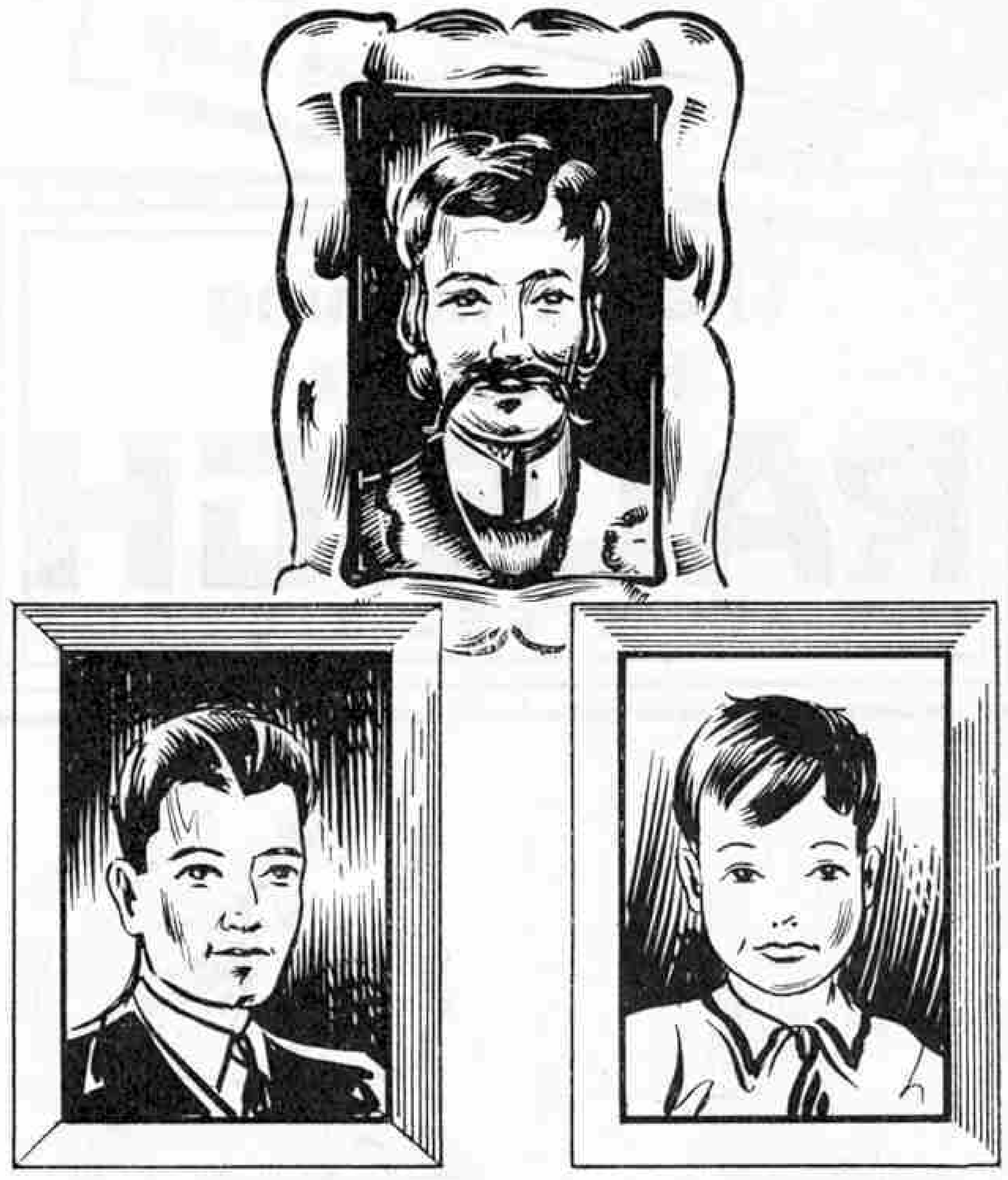

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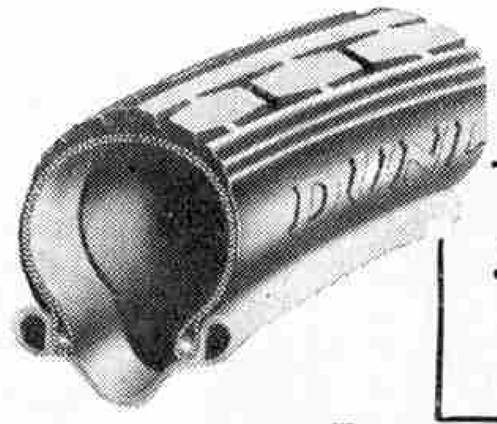

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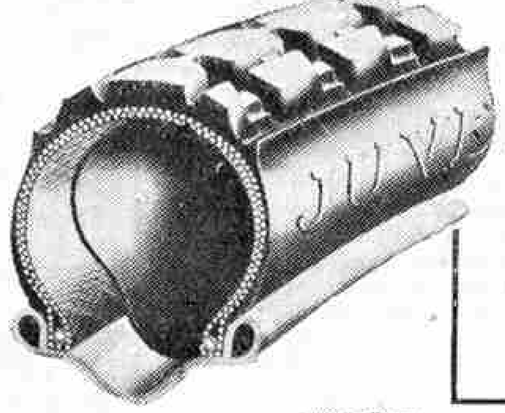
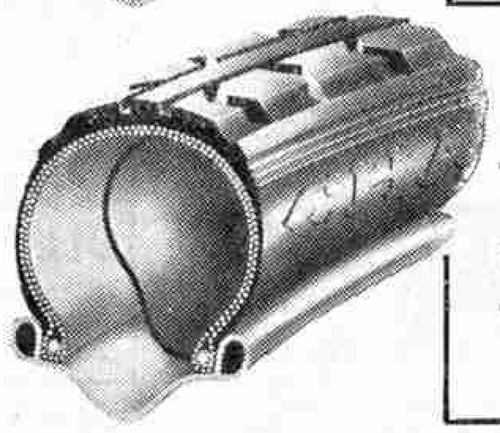
TUBE 2/6



DUNLOP SPORTS JUVENILE
COVER 4/6
TUBE 2/3



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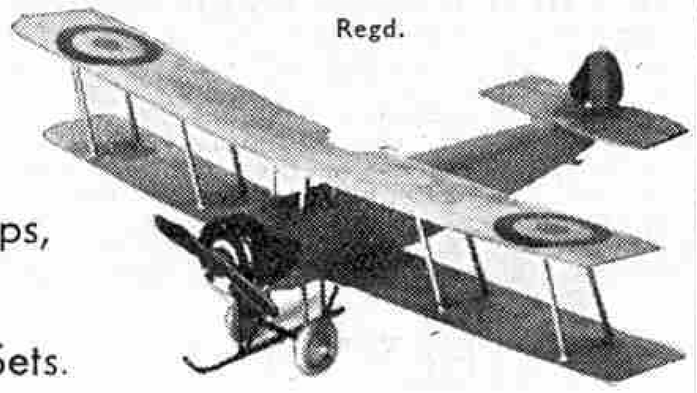

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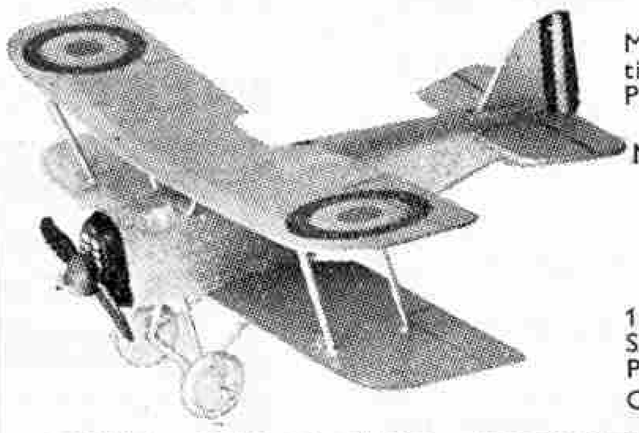

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The Guernsey Railway.
Notes on Scottish Locomotives and Railway Working, 1895-1910. IV—The Great North of Scotland Railway (*concluded*).
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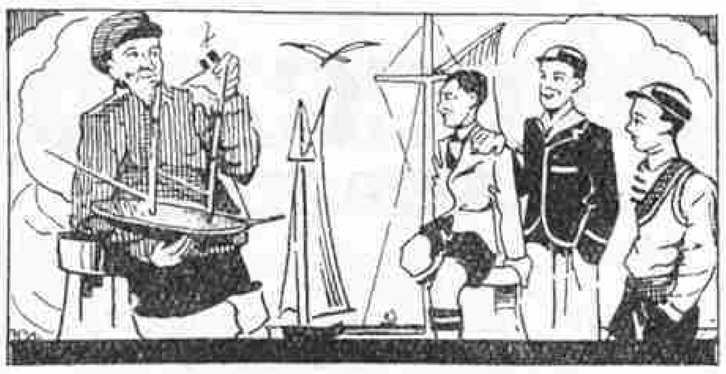

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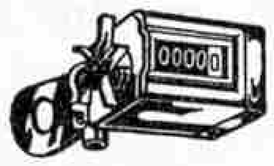

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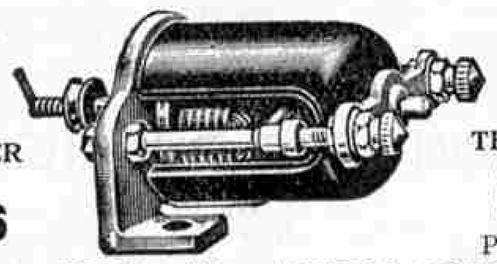

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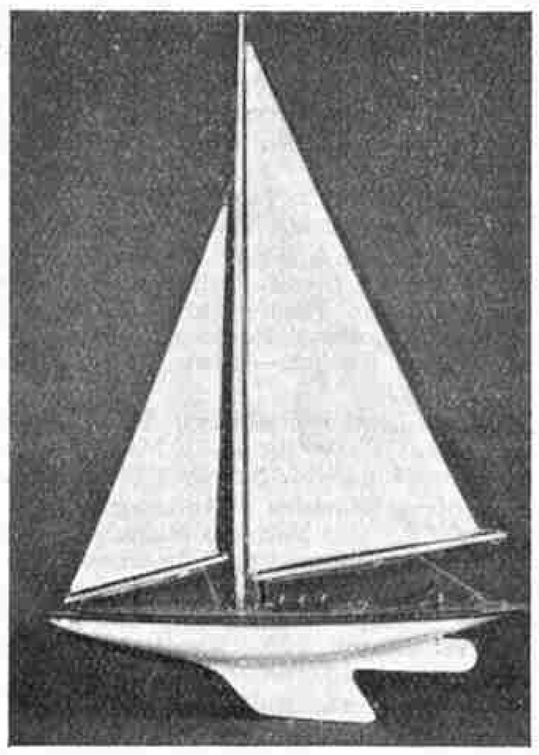

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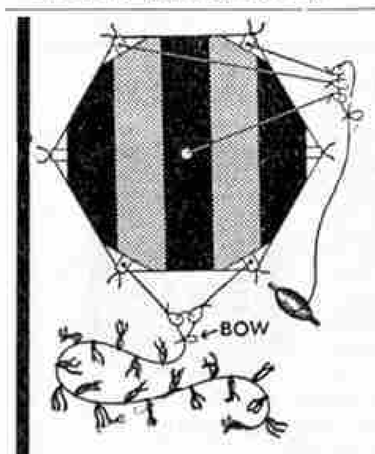

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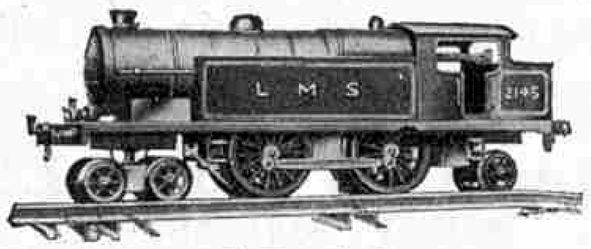

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To Contributors. The Editor will consider articles and photographs of general interest and payment will be made for those published. Whilst every care will be taken of articles, etc., submitted, the Editor cannot accept responsibility for any loss or damage. A stamped addressed envelope of the requisite size should be sent where the contribution is to be returned if unacceptable.

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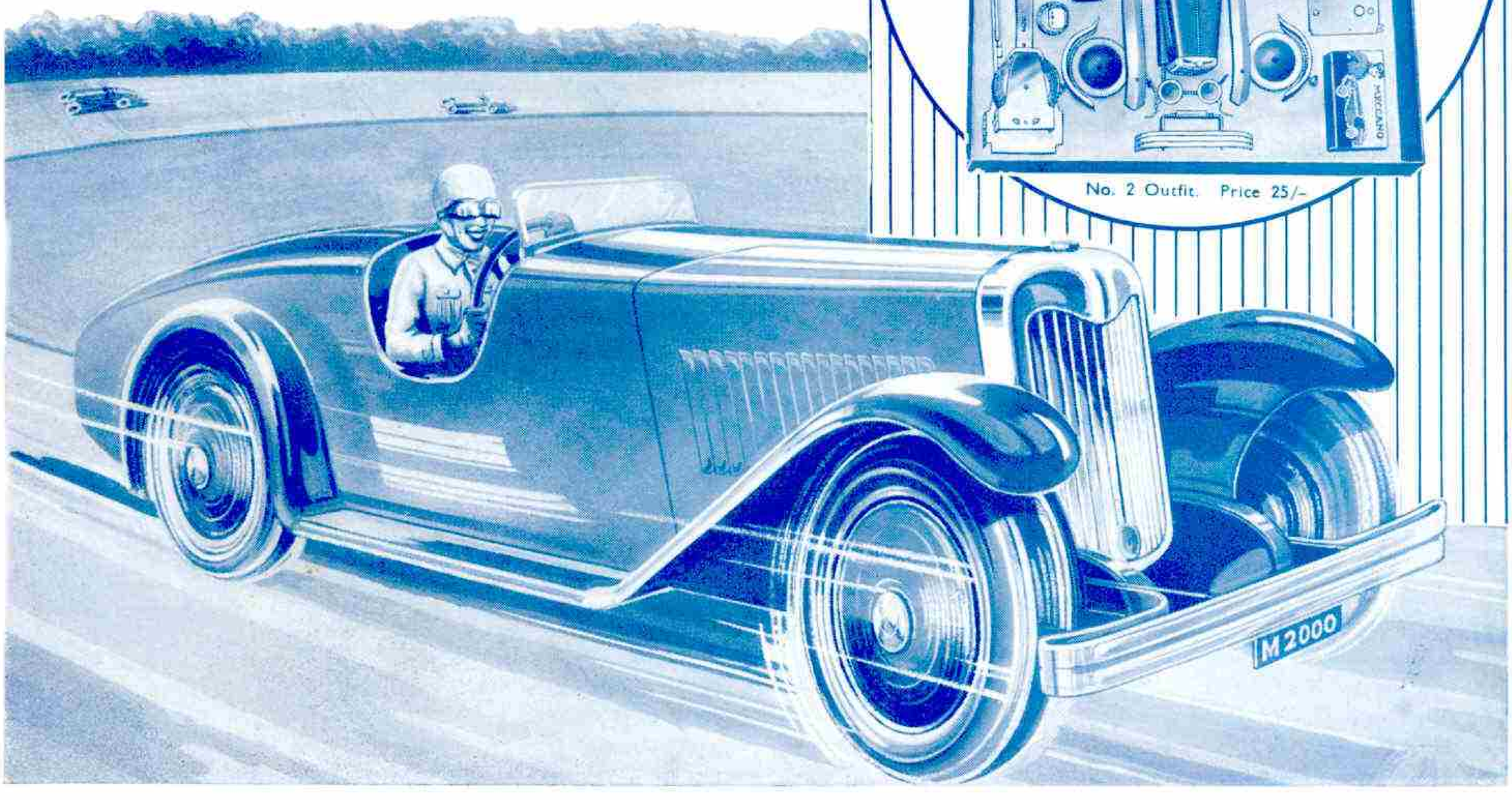

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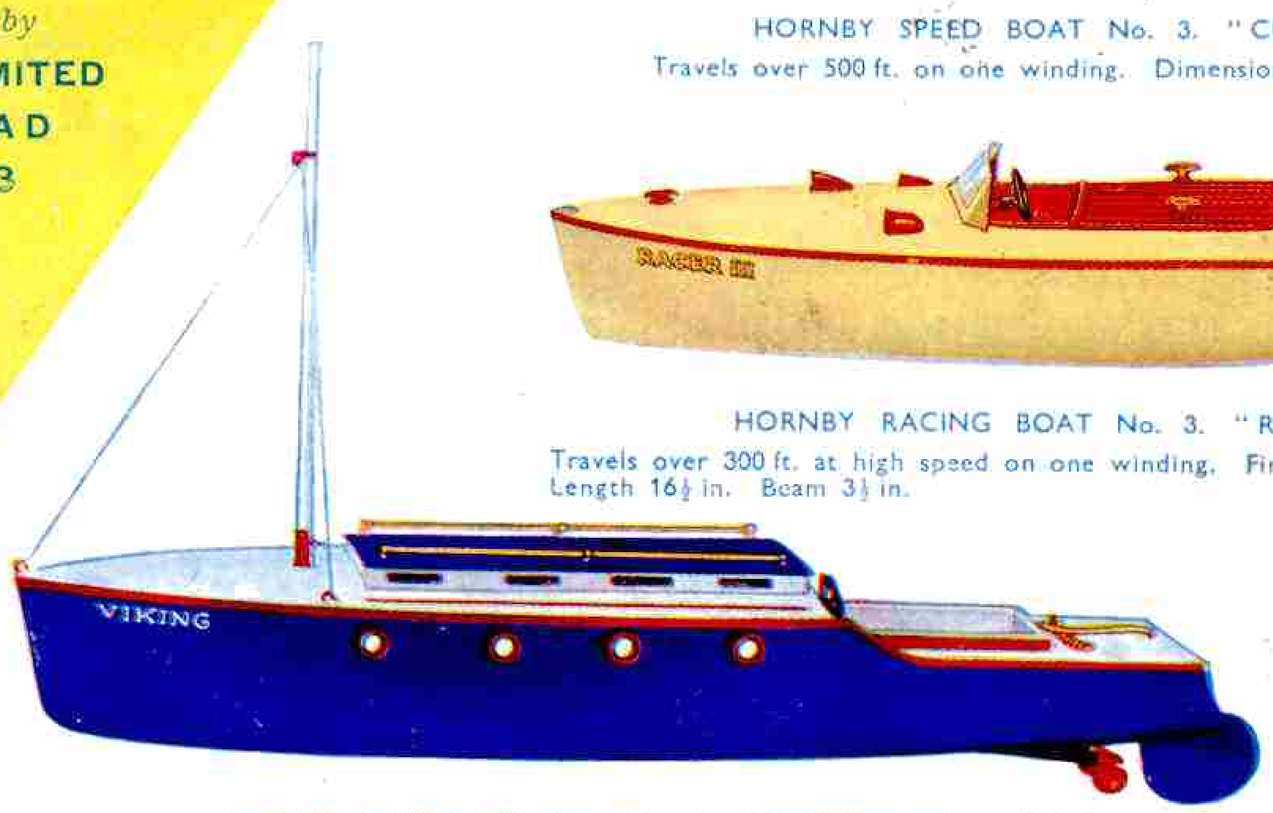

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